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JOURNAL OF THE SOCIETY OF ARTS.

No. 2244.] *FRIDAY, NOVEMBER 22, 1895.* *[Vol. XLIV.*

ONE-HUNDRED-AND-FORTY-SECOND SESSION, 1895-96.

COUNCIL.

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SESSIONAL ARRANGEMENTS.

The First Meeting of the One-Hundred-and-Forty-Second Session of the Society was held on Wednesday evening, the 20th of November, when the Opening Address was delivered by Major-General Sir John Donnelly, K.C.B., Vice-President, and Chairman of the Council. The following arrangements have been made for the four meetings before Christmas :—

Wednesday Evenings, at Eight o'clock :—

November 27.—H. H. Cunynghame, "Locomotive Carriages for Common Roads." Sir Frederick Bramwell, Bart., F.R.S., in the chair.

December 4.—Mrs. Anna Lea-Merritt and Prof. W. C. Roberts-Austen, C.B., F.R.S., "Mural Painting, with the Aid of Metallic Oxides and Soluble Silicates." W. Holman Hunt in the chair.

" 11.—F. A. Anderson, "Water Purification by means of Iron."

" 18.—John Southward, "Machines for Composing Letter-press Printing Surfaces."

Papers for meetings after Christmas :—

George Barham, "Dairy Produce."
Prof. Silvanus P. Thompson, D.Sc., F.R.S., "The Making of a Great University for London."
Prof. Haddon, "Some Native Irish Industries."
W. J. Dibden, F.C.S., "Standards of Light."

CAPT. W. DE W. ABNEY, C.B., F.R.S., "Orthochromatic Photography."
GLEESON WHITE, "The Poster and its Artistic Possibilities."
F. INIGO THOMAS, "The Garden in Relation to the House."
JOSEPH PENNELL, "English Book Illustration, 1860-70."
SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., "Punjab Irrigation, Ancient and Modern."
WALTER R. LAWRENCE, I.C.S., C.I.E., "The Economic Development of Kashmir."
A. J. HIPKINS, "Musical Pitch."
HUDSON MAXIM, "High Explosives and Smokeless Powders."
FRANK W. GRIERSON, "Supply of Sea-water to London."

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock :—

January 16, February 13, 27, March 12, April 23, May 14.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Afternoons, at Half-past Four o'clock, except when otherwise announced :—

December 17, January 28, February 18, March 3, 17, April 21, May 5.

DECEMBER 17.—FRANK CUNDALL, "Jamaica in the Past and Present." C. WASHINGTON EVES, C.M.G., will preside.

APPLIED ART SECTION.

The meetings of this Section will take place on the Tuesday Evenings, at Eight o'clock :—
January 14, February 4, 25, March 10, April 14, May 12.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday Evenings, at Eight o'clock :—

W. WORBY BEAUMONT, M.Inst.C.E., "Mechanical Road Carriages." Three Lectures.

LECTURE I.—DECEMBER 2.—Introduction—Easy transport: its attractiveness as a problem, and its national importance—Mechanical road carriages—Early inventions and achievements—Steam on common roads—Carriages and coaches—Success of English constructors—Close of early 19th century steam carriage enterprise.

LECTURE II.—DECEMBER 9.—Second period of 19th century invention and enterprise—Development of steam road locomotives and traction engines—Design and construction—General principles: details—Highways and road locomotives Act—Slow development under oppressive restrictions.

LECTURE III.—DECEMBER 16.—Renaissance of public interest in mechanical road carriages—Recent inventions and achievements—Steam, oil, gas, and electrical carriages, vans, and cycles—French, German, and English vehicles—Passenger carriages—Goods carriers—Roads—Legal restrictions—Pending legislation, probable great importance of mechanical carriage manufacturing industry, and advantages to traders.

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.
January 20, 27, February 3, 10.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Building Materials." Three Lectures.
February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.
March 9, 16, 23.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 1st and 8th of January, at Seven p.m., by PROF. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements, and Volcanoes."

CONVERSAZIONE.

The Annual Conversazione of the Society is provisionally fixed for Wednesday, June 17. Each member receives a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session, three of which during the Session 1895-6 will be at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr.

Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures Special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled :—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1895-96. It is issued subject to any necessary alterations:—

NOVEMBER, 1895.			*DECEMBER*, 1895.			*JANUARY*, 1896.			*FEBRUARY*, 1896.		
1	F		1	**S**		1	W	Juvenile Lecture I.	1	S	
2	S		2	M	Cantor Lecture I. 1	2	Th		2	**S**	
3	**S**		3	Tu		3	F		3	M	Cantor Lecture II. 3
4	M		4	W	Ordinary Meeting	4	S		4	Tu	Applied Art Section
5	Tu		5	Th		5	**S**		5	W	Ordinary Meeting
6	W		6	F		6	M		6	Th	
7	Th		7	S		7	Tu		7	F	
8	F		8	**S**		8	W	Juvenile Lecture II.	8	S	
9	S		9	M	Cantor Lecture I. 2	9	Th		9	**S**	
10	**S**		10	Tu		10	F		10	M	Cantor Lecture II. 4
11	M		11	W	Ordinary Meeting	11	S		11	Tu	
12	Tu		12	Th		12	**S**		12	W	Ordinary Meeting
13	W		13	F		13	M		13	Th	Indian Section
14	Th		14	S		14	Tu	Applied Art Section	14	F	
15	F		15	**S**		15	W	Ordinary Meeting	15	S	
16	S		16	M	Cantor Lecture I. 3	16	Th	Indian Section	16	**S**	
17	**S**		17	Tu	For. & Col. Section	17	F		17	M	Cantor Lecture III. 1
18	M		18	W	Ordinary Meeting	18	S		18	Tu	For. & Col. Section
19	Tu		19	Th		19	**S**		19	W	Ordinary Meeting
20	W	Ordinary Meeting	20	F		20	M	Cantor Lecture II. 1	20	Th	
21	Th	(Opening Meeting of	21	S		21	Tu		21	F	
22	F	the Session)	22	**S**		22	W	Ordinary Meeting	22	S	
23	S		23	M		23	Th		23	**S**	
24	**S**		24	Tu		24	F		24	M	Cantor Lecture III. 2
25	M		25	W	Christmas Day	25	S		25	Tu	Applied Art Section
26	Tu		26	Th	*Bank Holiday*	26	**S**		26	W	Ordinary Meeting
27	W	Ordinary Meeting	27	F		27	M	Cantor Lecture II. 2	27	Th	Indian Section
28	Th		28	S		28	Tu	For. & Col. Section	28	F	
29	F		29	**S**		29	W	Ordinary Meeting		S	
30	S		30	M		30	Th				
			31	Tu		31	F				

MARCH, 1896.			*APRIL*, 1896.			*MAY*, 1896.			*JUNE*, 1896.		
1	**S**		1	W		1	F		1	M	
2	M	Cantor Lecture III. 3	2	Th		2	S		2	Tu	
3	Tu	For. & Col. Section	3	F	Good Friday	3	**S**		3	W	
4	W	Ordinary Meeting	4	S		4	M	Cantor Lecture VI. 2	4	Th	
5	Th		5	**S**	Easter Sunday	5	Tu	For. & Col. Section	5	F	
6	F		6	M	*Bank Holiday*	6	W	Ordinary Meeting	6	S	
7	S		7	Tu		7	Th		7	**S**	
8	**S**		8	W		8	F		8	M	
9	M	Cantor Lecture IV. 1	9	Th		9	S		9	Tu	
10	Tu	Applied Art Section	10	F		10	**S**		10	W	
11	W	Ordinary Meeting	11	S		11	M	Cantor Lecture VI. 3	11	Th	
12	Th	Indian Section	12	**S**		12	Tu	Applied Art Section	12	F	
13	F		13	M	Cantor Lecture V. 1	13	W	Ordinary Meeting	13	S	
14	S		14	Tu	Applied Art Section	14	Th	Indian Section	14	**S**	
15	**S**		15	W	Ordinary Meeting	15	F		15	M	
16	M	Cantor Lecture IV. 2	16	Th		16	S		16	Tu	
17	Tu	For. & Col. Section	17	F		17	**S**		17	W	Conversazione
18	W	Ordinary Meeting	18	S		18	M	Cantor Lecture VI. 4	18	Th	
19	Th		19	**S**		19	Tu		19	F	
20	F		20	M	Cantor Lecture V. 2	20	W	Ordinary Meeting	20	S	
21	S		21	Tu	For. & Col. Section	21	Th		21	**S**	
22	**S**		22	W	Ordinary Meeting	22	F		22	M	
23	M	Cantor Lecture IV. 3	23	Th	Indian Section	23	S		23	Tu	
24	Tu		24	F		24	**S**	Whit Sunday	24	W	Annual General
25	W	Ordinary Meeting	25	S		25	M	*Bank Holiday*	25	Th	Meeting
26	Th		26	**S**		26	Tu		26	F	
27	F		27	M	Cantor Lecture VI. 1	27	W		27	S	
28	S		28	Tu		28	Th		28	**S**	
29	**S**		29	W	Ordinary Meeting	29	F		29	M	
30	M		30	Th		30	S		30	Tu	
31	Tu					31	**S**				

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian Section will commence at Half-past Four, and the Foreign and Colonial Section at either Half-past Four or Eight o'clock, as may be announced from time to time.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 20, 1895; Major-Gen. Sir JOHN DONNELLY, K.C B., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Adair, R. Shafto, 9, Lower Berkeley-street, Portman-square, W.

Barham, G. Titus, College-farm, Finchley, N.

Benest, Edward Benest Shaw, Caixa 403, Rio de Janeiro.

Bessemer, Alfred George, jun., 27, Killieser-avenue, Streatham-hill, S.W.

Blackburn, Thomas, Barmouth, North Wales.

Bloxam, William Tucker, 1, Lincoln's-inn-fields, W.C.

Briggs, Fielden, D.Sc., Tower-house, Whiteladies-road, Clifton, Bristol.

Browne, Frank, Government Civil Hospital, Hong Kong.

Browning, George Elliot, Blairgowerie, Coonoor, Southern India.

Burgoyne, John William Henry, The Bund, Shanghai, China.

Carulla, Señor Don Federico M., Apartado, 689, Buenos Ayres, South America.

Chandler, John E., Frenches-park, Crawley-down, Sussex.

Chapman, Ernest B. H., 23, Portway, Frome.

Charrington, Mowbray Vernon, The Warren, Hever, Edenbridge.

Cohn, Martin, 122, Elgin-crescent, Notting-hill, W.

Cornish, Miss Jane Square, 9, Maida-hill West, W.

Cragg, Anthony Richard, Maristow-cottage, Roborough, South Devon.

Cross, Right Hon. Viscount, G.C.B., G.C.S.I., 12, Warwick-square, S.W., and Eccle Riggs, Broughton-in-Furness, Lancashire.

Crowther, Charles, Greenmount, Central-street, Dewsbury.

Cuninghame, Richard John, Lainshaw, Stewarton, N.B.

Currie, Alexander John, M.D., 219, Onslow-drive, Dennistoun, Glasgow.

Davis, J. Kennard, Afon-house, Mortlake, S.W.

Davison, Henry, 2, Royal Exchange-buildings, E.C.

Dixon, Arthur William, 122, Abbey-road, St. John's-wood, N.W.

Edwards, G. F., Alger-house, 6, Highbury-crescent, Highbury, N.

Evans, George, 1, Wood-street, E.C.

Fowles, Joseph H., 13 and 15, Hornby-street, Heywood, Lancashire.

Gaskell, Francis, M.A., 14, Park-crescent, W.

Gleichen, Captain Count, St. James's-palace, S.W.

Green, Bernard, 42, Warbeck-road, Shepherd's-bush, W., and Ranelagh-road, Westbourne-square, Paddington, W.

Haig, Captain Douglas, 45, Albert-gate, S.W.

Hardman, Samuel, 225, Lord-street, Southport.

Harris, Colonel Josiah, Crofton-lodge, Sydenham, S.E.

Harrison, A. G., 95, Beechdale-road, Brixton-hill, S.W.

Holmes, James, 35, Murray-street, Burnley.

Howmann, S. A. W., 24, Ashbourne-road, Derby.

Jackson, Alfred, 1, St. James's-street, S.W.

Kellner, William, Ph.D., 13, Victoria-road, Old Charlton, Kent.

Kerr, Joseph Malcolm, Falls-mills, Gokak, Belgaum District, India.

Lipscombe, Frederick R., 233, Strand, W.C.

Lloyd, Sampson Zachary, J.P., Areley-hall, near Stourport.

Mabson, Richard R., The Ferns, Upper Hornsey-rise, N.

McGraw, Hugh, 1, Hornsey-lane, N.

Mangles, Henry Albert, Littleworth-cross, Seale, Surrey.

Marshall, Robert Andrew, Hazeldene, 67, Chelsham-road, Clapham, S.W.

Miers, Henry Alex., M.A., British Museum (Natural History), Cromwell-road, S.W.

Mills, George, Westholm, West Enfield, Middlesex.

Milton, Viscount, M.P., Wentworth Woodhouse, Rotherham.

Nugent, James, Chesterfield, Belfast, and 22, Corporation-street, Belfast.

Orr, Robert G., 73, Fitzjohn's-avenue, Hampstead, N.W.

Ottley, Lieut.-Colonel John Walter, R.E., C.I.E., Oakover, Simla, India.

Pearson, George, Brickendon Bury, Hertford, and 10, Victoria-street, S.W.

Priestley, Lawrence, Newark-on-Trent.

Pybus, Richard, Markeaton-mills, Derby.

Rainbow, Edwin, Park-view, The Butts, Coventry.

Ravenshaw, Thomas Edward, J.P., South-hill, Worth, Sussex.

Rigg, Rev. James Harrison, D.D., 79, Brixton-hill, S.W., and Westminster Training College, S.W.

Robinson, Stephen, J.P., Lynhales, Kington, Herefordshire.

Rowell, James, Boston, Lincolnshire.

Searle, James, New River-office, Clerkenwell, E.C.

Stanford, John Benett, J.P., Pyt-house, Tisbury, Wilts.

Stock, Henry Wm., B.A., 9, Denman-street, London-bridge, S.E.

Stott, James, Ravenscraig, Conway, North Wales, and Vernon Works, Oldham.

Tawney, Charles Henry, C.I.E., M.A., Hanover-house, Tonbridge.

Teare, William Frederick, Ballacooil-manor, Patrick, Isle of Man.

Toplis, Frederick, 129, Fellows-road, South Hampstead, N.W.
Turner, A. W., 8, Chowringhee-lane, Calcutta, India.
Tyler, Sir John William, C.I.E., M.D., Lucknow, Oudh, India.
Wade, Edward Hyde R. W., The Cliff, Ry Compound, Colombo, Ceylon.
Weston, Rev. Walter, Carlton-house, Wellington, Salop.
Wild, Ernest Edward, B.A., LL.B., 25, Great Russell-mansion, Great Russell-street, W.C.
Williams, Arnold, C.M., 4, Cumberland-gate, Kew, Surrey.
Willis, Edward, 21, Cornwall-gardens, Willesden-green, N.W.
Wills, William Arthur, 123, Bishopsgate-street, E.C.
Worthington, Herbert, J.P , Glyn-y-mel, Fishguard, South Wales.
Young, Frank Russell, 22, Palmerston-road, Walthamstow.

The CHAIRMAN delivered the following

ADDRESS.

As the Council have done me the honour to re-elect me as their Chairman for the present Session, it again becomes my duty, in conformity with the Bye-laws, to address the Society. In selecting the subject of that address there is some difficulty, as I have had already occasion to point out. My way is, however, in a manner indicated for me by the general drift of my address last year and by the immediate consequence of it—the Conference on the subject of the Examinations of the Society which took place in the rooms of the Society last June.

While giving a brief historical summary of the operations of the Society I dwelt, last November, more especially on those in which it concerned itself with matters which are now recognised under the somewhat nebulous term of Technical Instruction. I propose to bring before you to-night, as clearly as I can, the present state and position of technical instruction in this country. In order to do this, however, satisfactorily, it is necessary, I am sorry to say, to go over again some of the ground I covered last year. An address must be complete in itself; one cannot treat it as the second volume of one which came out last year. I trust I may apply the soothing salve to my conscience that those of my audience who did me the honour to listen to me on that occasion have so hazy a recollection of what I then said that they will forgive my recapitulation.

I cannot avoid it. There is, for instance, this initial difficulty. The term technical instruction has so wide a significance that it is necessary to state with some precision the limits of the subject as it is intended to deal with it; otherwise it might be considered that I had failed to recognise as technical instruction much that is being done in the country, and which, under a wider and possibly juster definition, would properly fall within its scope. I may say then that I intend to confine myself to technical instruction as contemplated by the Technical Instruction Act of 1889. According to that, technical instruction means instruction in the principles of science and art applicable to industries, and in the applications of special branches of science and art to specific industries or employments. It includes all those branches of science and art with respect to which grants are made by the Science and Art Department, and any other form of instruction—including modern languages and commercial and agricultural subjects—which may be sanctioned by the Department of Science and Art by minute, on the representation of a local authority that such form of instruction is required by the circumstances of its district. Under manual instruction, the Act further includes instruction in the use of tools, processes of agriculture, and modelling in clay, wood, and other material. But, and it is necessary to bear this in mind, the definition clause expressly excludes "teaching the practice of any trade or industry or employment."

Technical instruction then, as thus defined, does not include, on the one hand, professional education such as that of the lawyer, the surgeon or physician, or the engineer; or, on the other hand, the trades of the carpenter, mason, bricklayer, or butcher. In any general, or indeed strict dictionary, sense of the term there can be no doubt but that the instruction which the young aspirant to membership of the recognised professions, or of the recognised trades, goes through is distinctly technical—probably more really technical than that which he may receive under the provisions of the Act. But I do not propose to consider any such technical instruction, which is outside the Technical Instruction Act, to-night, not because it is not important—on the contrary, it is quite as important as what I am considering—but because it is so vast and intricate a subject that nothing but a Royal Commission, or the editor of "Whitaker's Almanack," could bring it into shape for presentment in a moderate compass. One must draw the line somewhere, even in addressing the Society of Arts, wide as its operations and sympathies are, and I think it can be shown that the limits I am taking are not purely artificial—that between the technical instruction of the Act and the rest of technical instruction there is a generic difference, though possibly the specific limits, in certain cases, are not so readily recognisable. For instance, I have seen, from cuttings of newspapers—for which I am indebted to the researches of Messrs. Romeike and Curtice—that many learned publicists have been much exercised by finding that the Science and Art Department has drawn a distinction between popular lectures or instruction on health and nursing given generally to the inhabitants of a town or village, and the specific instruction of one or two persons, selected from those villages to become trained nurses or midwives for a certain number of years, as part of their quasi scholarship engagement. It has seemed monstrous and illogical to these gentlemen that the Department should advise local authorities—and it can only advise in such a matter—that in the one case they have a legitimate expenditure of funds under the Technical Instruction Act and not in the other. It will, however, I think, be clear, on a little consideration, that in many such instances—and I only mention this as an example—rapidly as one kind of instruction may merge from the other, there is a real difference—the difference between giving general information as to how a thing can and should be done, and so instructing and practising the pupil as to make him a craftsman in the trade or profession.

Some light may be thrown on this question of technical instruction if we consider how the demand for it arose. In matters educational the schoolmaster is a despot, and his despotism is untempered by assassination. He is one of too many to be affected in that way. His is an enormous profession, largely endowed; with the universities at one end of the line and the village school at the other. It is interwoven — with ideas, interests, traditions in common; a priesthood with a cultus, that of strengthening, enlarging, and improving the brain or intellect much as a good teacher of gymnastics endeavours to strengthen and enlarge the physical frame generally. In neither case is any special or practical application the direct object in view, however much the mind or the body, as the case may be, may be cultivated and prepared for special applications by such general training. I am not saying that the educationist is wrong; there is much to be said for his views; I am only stating facts. Further, his is a very conservative profession. It is loth to change the subjects of instruction which it has become the practice to use as the apparatus of mental gymnastics. When first adopted they are naturally more or less connected with the needs and affairs of ordinary life, or fitted to lead directly to them. But as the circumstances of the world change, they fall more and more out of gear with those needs, and become dissevered from everyday concerns. I think everyone who is conversant with the state of general education in this country about the middle of the present century will admit that its subjects had then so fallen behind the time that the student, however proficient he might be on its parallel bars, found that, unless he turned to teaching or literature as a profession, he had a wide gulf to cross and a good deal to acquire before he could apply the enlarged muscles of his mind to obtaining bread and butter.

About the same time—say 1840, or even earlier—all kinds of trades, manufactures, and industries became more and more specialised; the apprenticeship system, by which the young man obtained some general all-round knowledge of his business or art, fell more and more into desuetude, and the workman became almost as much a specialised machine as that which he tended from unlettered childhood to the grave or the workhouse. Coincidently with this, the applications of science and scientific methods to manufactures and industries of all kinds became a burning question in the ceaseless and remorseless battle of industrial competition.

It is scarcely necessary to say that my picture is of the broadest kind—purely impressionist. To fill in the details would take far more time than I can command, or ask of your patience. I am only endeavouring to show where and how the demand for art instruction and technical education came in, with a view to show the nature of instruction aimed at. I do not think I am far wrong in saying that it was owing, on the one hand, to our general educational system being found very defective as a preparation for those who were to take part in the industrial competition; and, on the other hand, to the rapid changes in the whole industrial environment, which rendered it difficult, if not impossible, for any one to obtain a general and wide knowledge of a trade or business—such, in fact, as he required to enable him to fill properly the position of manager, or even that of foreman—in the trade itself. It will be seen from what I have said that general secondary education—the school instruction that is, as I understand it, which comes between the elementary school and the higher colleges and universities of the country—does not fall within this idea of technical instruction. If this hasty sketch of the origin of the movement for technical instruction be correct there is some justification for the limits I have ventured to put upon the term in this paper — as the something for which the want was felt, between the ordinary scholastic instruction and the distinctly technical instruction of the workshop and the counting-house.

However this may be, there can be no doubt that the movement in favour of a State-aided system of technical instruction rapidly developed during the last half of the present century, till it culminated in the Technical Instruction Act of 1889. It commenced with Mr. Ewart's Committee of the House of Commons, in 1835, on art instruction. This led to the creation, first under the Board of Trade, of the Department of Practical Art, and then of the Department of Science and Art, under the Committee of Council on Education. The movement was stimulated, led, and organised—as is the case in all such movements—by certain men gifted with foresight. I do not mention their names because they are, at all events at present, well known, and I hesitate to particularise lest I fall into invidious comparisons where so many have worked earnestly.

It was soon found in the progress of this new crusade, that the operations must be extended over a very wide field. Mr. Samuelson's Committee of the House of Commons, in 1868, called serious attention to the necessity for greatly improved elementary instruction before much progress could be made by the working classes in scientific or technical instruction. I said so much on this subject in my address last year, and on the influence the report of that Committee had on the Elementary Education Act of 1872, that it is unnecessary to dwell further on them now. But in taking a general survey of the present position of technical instruction in the country, it is necessary to note what is being done in the elementary schools as a more or less direct preparation for that instruction.

In the forefront of such educational preparation we must place elementary instruction in freehand, and geometrical or mechanical drawing. This, instead of being, as formerly, a sporadic *etcetera*, has, since 1891, been a compulsory subject in all boys' schools in England and Wales, and an optional one for girls, when cookery is also taught. Last year—ending August, 1895—drawing was taught in about 19,300 elementary schools in England and Wales to about 2,000,000 children.

Drawing is not a compulsory subject under the Scotch Code, but last year about 1,000 Scottish schools, with about 250,000 children, took drawing under the Science and Art Department.

In Ireland, the drawing in schools under the Board of National Education is provided for by that Board. The Science and Art Department has nothing to do with it. As far as I can judge from the statistics in the report of the Board for 1894, it was taken as an extra and optional subject in 1,303 schools by 62,200 scholars. The payments made for drawing, music, and kindergarten, were about £18,540. As regards schools not under the National Board a few, about 95, elementary schools, with 20,000 scholars, principally schools conducted by the Christian Brothers, take drawing under the Science and Art Department, and obtain grants from it.

Elementary drawing is also taught in evening continuation schools in England and Scotland, and grants were made for it by the Science and Art Department last year in 712 such schools with 35,600 scholars.

In elementary schools grants are also made by the Science and Art Department for manual instruction, that is to say, instruction in the use of the ordinary tools used in handicrafts, in wood and iron, where the school is provided with a proper workshop. There were last year 970 so aided schools in England and Wales, 60 in Scotland, and 2 in Ireland, with altogether 45,000 scholars

The grants for elementary school drawing and manual instruction, amounted altogether, with the cost of examination and inspection, during the last financial year to about £200,000.

Under the English and Scotch Codes, and the regulations of the National Board in Ireland, a considerable and increasing amount of elementary science and technical instruction is being given to the children as part of the regular work in the schools—mathematics, natural science, agriculture, horticulture, cookery, laundry, needlework, and so on.

And again, in the evening continuation schools under the English and Scotch Codes, which received grants of nearly £120,000 in the year ending August, 1894, these elementary sciences and technical subjects formed a considerable part of the instruction given. But highly important as this instruction is in the general drift of scientific and technical instruction in the kingdom, I do not propose to dwell upon it any further now, as it appears to me to fall somewhat outside the border line of such technical instruction as I have professed to consider this evening; local authorities being precluded from granting aid out of moneys received under the Technical Instruction Act or the Local Taxation (Customs and Excise) Act to scholars at an elementary school receiving instruction in the obligatory or standard subjects of reading, writing, and arithmetic.

To come now to the specific matters which fall within the province of the Technical Instruction Act, you will remember, from the definition which I have already quoted, that all subjects of instruction in science and art, with respect to which grants are made by the Science and Art Department are, *ipso facto*, included as proper subjects for aid under that Act. The Customs and Excise Act incorporates the Technical Instruction Act, 1889, in so far that it provides that the residue or any part of it may be applied in England and Wales, for the purposes of technical instruction, within the meaning of that Act; and in Scotland of the Technical Schools (Scotland) Act, 1887. The subjects of science thus included cover a wide range. In the first place we have the more or less pure sciences of mathematics, mechanics, chemistry, physics, zoology, botany, physiology, physiography, geology, and mineralogy; then the applied sciences of practical geometry and mechanical drawing, applied mechanics, steam, and metallurgy, and, lastly, those which are, perhaps, properly speaking, technological — machine construction, building construction, naval architecture, navigation, nautical astronomy, principles of mining, principles of agriculture and hygiene.

The art subjects practically cover the whole range of instruction in art—drawing, painting, and modelling from copies, from casts and still life, and from life—with a superstructure of architecture, decorative work, and designing.

It is unnecessary to trouble you with any elaborate statistics with regard to the science and art schools under the Science and Art Department; it will be sufficient if I give the broad outlines. There were, then, about 2,640 science schools examined last May, some of which have courses of instruction in a number of branches of science, while others consist of classes in one or two subjects only. The number of students under instruction was over 190,000, of whom something over 100,000 were examined, more than 200,000 papers being worked. The examinations in training colleges are included in these figures. The payments on results are not yet known, but judging by the Estimates, they will amount to about £156,000, of which sum £126,000 will be taken by England and Wales, £24,000 by Scotland, and £6,000 odd by Ireland, Ireland receiving from the Department about £2,500 more as a grant in aid for technical instruction.

On the art side, 227 schools of art and 1,622 art classes were examined, the number of students under instruction being over 140,000. The number of papers worked at the examinations was over 150,000, while considerably more than 100,000 school works, executed during the session, were sent up to South Kensington, the selection for the national competition being made from them. The Estimates for the current year provide rather more than £74,000 for the payments, prizes, &c., in art, of which sum £60,000 will go to England, £8,000 to Scotland, and £7,000 odd to Ireland.

In these sums I am not including the cost of inspection and examination, the allowance made for training of teachers and the cost of maintenance of those two institutions for higher scientific, technical, and art instruction, the Royal College of Science with its incorporated Royal School of Mines, and the National Art Training School at South Kensington. For these various services the Estimates provide about £84,000.

Before concluding this brief account of what the State does directly for technical instruction of the kind with which I am dealing, I must not omit to mention the South Kensington Museum, the Bethnal-green Museum, and the Geological Museum in Jermyn-street; the Science and Art Museums in Edinburgh and Dublin, and the Royal College of Science in Dublin; lastly, as far as the Science and Art Department is concerned, we have the money aid given to provincial museums for purchases, which is small, and the aid given by the circulation of loans to these museums, which is considerable, as you will understand, when I tell you that, according to the report of the Department for last year, fifty such museums were on the list for permanent loans. These loans are changed once a year. In this way, and in temporary exhibitions and science and art schools nearly 29,000 objects were on loan during the year. The Geological Survey, the National Library and Botanic Gardens in Dublin, and one or two other minor objects for which grants are made by the Department, scarcely fall within the subject I am dealing with this evening. Excluding them, the grants for those which are distinctly within its scope, with the cost of administration, amount to about £492,000, in addition to the sum of about £212,000 required for drawing and manual instruction in elementary schools, and science and art instruction in training colleges.

Much is done by the Government directly for purely technical instruction by the schools and colleges under the Admiralty and the War Office, and also by the Industrial Schools under the Poor-law Board; but any account of this I purposely omit for the reasons I have already given. Our survey would, however, be incomplete, as regards the direct action of the State, if I failed to notice what the Agricultural Department is doing for instruction.

In 1894-5, the total vote entrusted to the Board of Agriculture for educational purposes was £8,000, of which £7,400 was distributed in specific grants to 17 institutions, the balance being applied to inspection of the work of various bodies which had applied for assistance in this direction; £5,000 was given in aid of agricultural education in connection with collegiate centres, £950 to instruction in dairying, £250 to local agricultural schools and classes, and £650 for field experiments and research.

I have been dealing with Government supported or Government aided technical instruction, but I must not omit to mention what is being done outside the sphere of State action by the City and Guilds of London in their well equipped Central Technical College at South Kensington; in their Technical College at Finsbury; and by means of their payments on results of examination in technology to registered classes in the metropolitan area. These amounted last year to £665; while the gross expenditure on the College at South Kensington amounts to about £12,000 a year, and that on the College at Finsbury to about £10,000 a year, a certain amount in each case being recouped by students' fees. The City and Guilds also aid or maintain a school of art wood-carving in the institute at South Kensington; and the Goldsmiths' Company have founded and endowed a fine technical school at New-cross, which also receives grants from the Science and Art Department.

Several of the City companies have also given substantial assistance to provincial colleges, such as the Yorkshire College at Leeds, where much special technical instruction is being given. Time will not allow of my giving details with regard to these, which, indeed, are rather for a directory of technical instruction than for such a general survey as I am attempting to-night. I allude to these institutions, to prevent it being supposed that they had been forgotten or purposely omitted.

We come now to the Technical Instruction Act, and the enlargement of the scope of State-aided instruction conferred thereby. The Act itself simply enabled local authorities to apply rates, not exceeding 1d. in the £, to technical instruction as defined in the Act. I should, perhaps, mention here that the Public Libraries Acts, the first of which was passed by Mr. W. Ewart in 1850, also gave powers to rate to the same extent for public libraries, museums, and science and art schools; and this Act, with the subsequent amending Acts, though not very largely availed of, has been by no means a dead letter either in respect of public libraries, museums, or schools of science and art.

In order to further the application of the Technical Instruction Act, the Science and Art Department was enabled by the Treasury to make a special grant in aid, where localities rated themselves under it, towards instruction in subjects other than those for which payments were made under the rules of the Science and Art Directory. This special grant as well as the grants for apparatus and fittings in science and art schools, was withdrawn, except as regards Ireland, in 1891, under the following circumstances.

In 1890, the Local Taxation (Customs and Excise) Bill was before Parliament; but difficulties supervened with regard to the application of some of the proceeds. The clause or clauses with regard to the residue carried an argosy of something well over three quarters of a million a year, a richer prize than the Spanish galleons which Blake went out to capture ever carried. It got adrift from its moorings, or perhaps it would be more correct to say that it could not make the port for which it was intended. The derelict argosy was, fortunately for technical instruction, piloted by Mr. Acland, into port. It is generally foolish to speculate on what might have been. There can, however, I think, be no kind of doubt that, but for the fortunate circumstance of the Technical Instruction Act having provided a harbour of refuge, technical instruction at the present moment would be in a very different position from that in which it finds itself.

I now propose to lay before you as succinctly as I can how this money is being applied. To make the whole matter clear, I must begin with Ireland, though my statement with regard to that country must be somewhat on the lines of the celebrated chapter on snakes in Iceland. The fact is, the whole of the residue grant due to Ireland was applied to purposes other than technical instruction, by the Customs and Excise Act of 1890. But Ireland has not been altogether a loser by this. For the aid to technical instruction given by the Science and Art Department, to which I have already referred, which ceased, as regards England and Scotland, after the passing of the Customs' and Excise Act, has been not only continued, but increased, as regards Ireland. For each £ raised by rates in that country, under the Technical Instruction Act, and applied to subjects other than those included in the Science and Art Directory, that Department makes a special grant in aid of another £. Though Ireland thus obtains more money in this way, proportionately, than England and Scotland, there is a drawback to the arrangement, from the point of view of technical instruction. The grants to the schools of science and art in Ireland for instruction in the subjects of the Science and Art Directory cannot be supplemented, as they can be in England and Scotland, out of the "beer money."

In Scotland, though the residue applicable to technical instruction was considerable, it was proportionately not so large as in England and Wales, because in the latter case it was the whole residue of the English share of the customs and excise duties, after deducting the sum fixed for police superannuation; whereas in Scotland it was the residue of their share after not only the police superannuation fund had been deducted but also other sums which were allocated to the payment of school fees and to the cost of certain medical officers and sanitary inspectors.

Under the English Technical Instruction Act the local authority is the council of any county or borough and any urban sanitary authority: and in England the residue grant is handed over to the councils of counties and county boroughs, who may apply it, if they please, for the purposes of technical education, within the meaning of the Technical Instruction Act. Under the Technical Schools (Scotand) Act, 1887, the School Board is the local authority, while the residue grant is divided up, in proportion to their respective valuations, among the county councils of counties and town councils acting as such, or as police commissioners of burghs, and police commissioners of police burghs.

They may contribute any part of the residue to technical education within the meaning of the Technical Schools (Scotland) Act, their powers being further enlarged by the Technical Instruction Amendment (Scotland) Act, 1892.

Thus the residue is subdivided into a number of (in some cases) very small sums, and their application is placed in the hands of authorities other than under the Technical Schools Act.

This, among other reasons, may have tended to retard the application of the residue grants to technical instruction in Scotland. Be the reasons, however, what they may, as a matter of fact the Technical Schools (Scotland) Act has, I believe, only been applied in about four or five places in Scotland, and of Scotland's share of the residue grant—about £50,000 to £55,000—applicable to technical instruction, I do not think that more than about £36,000 was so devoted during the year ending 31st March, 1895; the rest being applied, I suppose, in relief of rates.

Wales is in the same position as England with regard to the proportion of the residue which can be applied to technical instruction. But the Customs and Excise Act provides that in any county to which the Welsh Intermediate Education Act, 1889, applies—that is to say Wales and Monmouthshire—the council of that county—but not as I read the Act of the County Borough—may apply the whole or any part of the residue towards intermediate and technical education under that Act. It became, therefore, very difficult, if not impossible, with the information at present obtainable, to say what, or how much, is being done for specific technical instruction, as distinct from general intermediate education. I must content myself, therefore, with saying that it appears that the 13 county councils and the 3 county boroughs in Wales and Monmouth are devoting the whole of the residue to intermediate and technical education, principally under the provisions of the Welsh Intermediate Education Act. The residue amounted, for the financial year (1823-4) to £30,096. But, in addition to this, the councils of seven counties and county boroughs, were, at the same time, levying a rate, under the Technical Instruction Act, which, it was estimated, would yield about £17,000. Some of these funds are accumulating, pending the passing of schemes and the erection of schools. It ought also to be said, to the credit of Wales, that the sum of about £17,400 a year is being —or will eventually be—raised, under the Welsh Intermediate Education Act, over and above the sums to which I have referred.

Coming now to England, or rather England less Monmouth, its share of the residue grant, which varies slightly from year to year, may be taken at £750,000. This sum is divided (according to their rateable value), among the 49 administrative counties, and 61 county boroughs, or such as have a population of 50,000 or upwards; the administrative counties being the divisions under the Local Government Act, 1888, according to which London is a county, and Lincolnshire counts as three counties. Forty-one of these counties were, as far as I can gather, devoting the whole of their share of the residue, amounting to about £368,000, to technical instruction. The remaining 8 counties, whose share amounted to £228,196, devoted about £83,000 in the same way. Of the 61 county boroughs, 53 applied the whole of their share of the residue—about £132,000—to technical instruction. Seven other county boroughs, whose share was £19,403, so applied a part, about £13,800. One county borough only, Preston, gave none of its share, £1,688, to technical instruction.

In nearly all cases the grant of one year, when devoted to technical instruction, is so expended during the following year. It is, therefore, impossible to give a precise statement of receipts and expenditure, but it will be near enough to put it thus:—Of the whole residue grant of £750,000, received by England, exclusive of Monmouth, a sum of about £600,000 was devoted to technical instruction in some form, the rest going to the relief of rates. And when I tell you that of London's share of £172,758, only £57,000 was allocated to technical instruction, it will be seen that a large part of the balance is accounted for: and it is evident that otherwise, that is to say, in the country generally, an astonishingly small portion of the residue goes in relief of rates.

Seeing how large an amount, some £600,000 in England alone, is being devoted in this way to technical instruction, it is not a little surprising that many towns are in addition rating themselves for the same purpose. But so it is, and we find, in fact, that the "beer" money has acted as a stimulant, and not as a soporific. During the past year 9 County Boroughs, 50 Boroughs, and 85 Urban Districts in England raised rates, or made grants out of the rates, under the Technical Instruction Act, amounting to about £35,000, in addition to what was received under the Customs and Excise Act. A considerable portion of this is being devoted to building schools and laboratories, and some splendid and well-equipped schools have been, and are being, established in all parts of the country by money so raised, and by large voluntary contributions. Some counties have made it a condition of their grants from the "beer" money that money shall be raised locally under the Technical Instruction Act, and this has no doubt furthered the application of that Act. But, however this may be, it is obvious that there was, and is, a strong feeling in the country as to the pressing necessity for all that goes under the name of technical instruction.

The next point for consideration is as to how all this money is being applied—in what proportion to different subjects of instruction. As I have already stated, all subjects of the Science and Art Directory fall within the Technical Instruction Act; for others, special Minutes are required. Two or three hundred subjects have been so brought within the Act by Minutes for different local authorities. I will not weary you by recapitulating them. It will be sufficient, I think, if I treat them in classes. We have, then, as Class 1, agricultural subjects from the principles of agriculture—which is one of the subjects of the Science and Art Directory—to the whole of the subsidiary branches, dairying, poultry and bee keeping, horticulture, veterinary work, hedging, ditching and sheep-shearing, agricultural experiments, and so on.

As Class 2, I take what may be called the technological subjects, such as electrical and mechanical engineering, plumbing, sanitary science, textile fabrics, and the other subjects which are included in the scheme of examinations of the City and Guilds of London Technical Institute.

Class 3 includes all the commercial subjects, modern languages, book-keeping, shorthand, &c.

Class 4. Manual instruction, carpentry, wood-carving, leather, glass, clay, basket work, and so on.

Class 5. Domestic and other subjects, mainly for women, such as nursing, domestic economy, cookery, laundry work, dressmaking, &c.

Class 6. Other subjects which cannot be well classified in the foregoing, such as music, ambulance work, and fish culture.

Now it appears—and in what I am going to say you must understand that I am only speaking very roughly, for though I have had, in analysing the returns, and in preparing these and the other statistics, the invaluable assistance of my friend, Mr. Garrard, of the Science and Art Department, who knows as much about them as anybody, the fact is, the data are not sufficient to base anything but a rough estimate about them — it appears that, in 1893-4, all the 49 county councils and all the 61 county boroughs in England, with one doubtful exception, give aid to the subjects of instruction included in the Science and Art Directory, such aid amounting to about £185,000 in the year 1893-4 out of the "beer" money.

All the county councils and four of the county boroughs gave aid, amounting to about £80,000, to agricultural subjects. But it would be a mistake to suppose that this was all the aid given to those subjects, as some of the £185,000 already mentioned went to the principles of agriculture.

Thirty-three county councils and 41 county boroughs gave aid to some of the technological subjects which I call Class 2, the amount of the aid being about £90,000.

The commercial subjects, Class 3, including modern languages, were aided by 46 county councils and 39 county boroughs, the grants amounting to about £50,000.

The manual instruction, Class 4, was aided by 46 county councils and 43 county boroughs to the extext of about £65,000, while about £55,000 was given by the 49 county councils and 38 of the county boroughs to domestic economy subjects included under Class 5; and about £30,000 to the other subjects such as ambulance work, which I have put under Class 6, by 42 county councils and 15 county boroughs. The sum of about £25,000 raised by local authorities under the Technical Instruction Act, in addition to the foregoing, was spent very much in the same way.

This distribution of grants under the various classes is taken from the returns for 1893-4, when the total amount spent was about £555,000 from "beer" money, and about £25,000 from rates. The estimated expenditure for 1894-5 was about £620,000 from "beer" money, and about £35,000 from rates. It cannot, of course, be stated for certain at present that the expenditure under the several classes was precisely in the same proportion as in the previous year, but there is no reason to suppose that there was any considerable change.

In stating that certain sums are given in aid of certain branches of instruction, it must be clearly understood that I do not mean that that sum of money was given wholly to aid the instruction in those subjects. A good deal is given in scholarships to students. As far as possible the amounts of the scholarships and exhibitions have been accredited to the subjects for which they have been awarded. The total amount given in scholarships and exhibitions, including payment of fees and travelling expenses during the year 1893-4, appears to have been over £50,000.

One of the points which surprised us most when we got out these figures was the very large sum, £185,000—one-third of the whole amount spent out of the "beer" money—which was given in aid of the subjects included in the Science and Art Directory, and of the schools and classes under the Science and Art Department. It was surprising, because, as so much has been said and written with regard to the uselessness and too theoretical character of the instruction given in those classes, local authorities, seeing that large grants were made for them directly by the State, might naturally have been expected to turn their attention and aid to a greater extent to the so-called more practical subjects. It is satisfactory to find that, on the contrary, local authorities, when they had a free hand in the matter, have so soon realised the great importance of sound instruction in the principles of abstract science, and in a disciplinary course of instruction in Art, as the only sure and sound foundation for further technical instruction.

The machinery through which, or by which, the instruction is imparted is an important matter. It would, however, take too long to describe this in any detail, but it may be well to call attention to the two broad divisions into which it naturally falls. The whole of this instruction is, in a sense, secondary instruction; that is to say, instruction supervening on that of the elementary school. But when we speak of secondary schools, we generally mean schools which the boy or girl attends, while still *in statu pupillari*, and not earning his or her own livelihood or any part of it, to receive an education higher than that of the elementary school. Some portion of the money received by local authorities under the Customs and Excise Act—between £20,000 and £25,000—was allocated last year for instruction in such schools — grammar schools and organised science schools under the Science and Art Department — either in the form of scholarships, direct aid to instruction, or for apparatus and plant. But, by far the larger part of their funds, and of the grants from the Science and Art Department, as well as of the sums raised by urban authorities under the Technical Instruction Act, are expended on instruction given in evening classes for the benefit of those who have left school, and are wholly or in part earning their own livelihood. In fact, a considerable part even of the sum allocated to grammar schools was for evening classes in them.

This is a curious and interesting development of secondary and technical instruction, which, as far as I am aware, if it obtains at all, obtains, to a very limited extent, on the Continent, even in those countries where secondary instruction, by means of secondary schools proper, is perhaps more developed or more organised than in this country. The effect of this was brought very forcibly to my mind some years ago by a conversation I had with one of the leading chemists in the Polytechnicum at Charlottenberg, near Berlin. He had, for some years previously, been chemist to some works in England, and knew our system. In order to enter a university in Prussia the student must bring—if a German—the leaving certificate of a *gymnasium*; from foreigners this is not required. To enter a polytechnic the leaving certificate of a *real schüle* or a *gymnasium* is necessary. The same rule extends, with slight modification in some States, over the whole of Germany. This means that the German youth must have attended a day secondary school till the age of, say, 17 or 18. In Germany, or in Prussia, at all events, there were, he said, no such things for workmen as evening classes for instruction in science; there might be a few drawing classes in connection with certain trades. The workman had practically little or no opportunity of advancing himself in that way. Once a workman always a workman was, to all intents and purposes, the invariable rule. The result, as he put it, was a caste system nearly as rigid as that in our Indian Empire. In Germany the higher posts in works were filled by highly instructed technical men, drawn from the polytechnics and universities. They give orders much as officers give orders on parade, and they are unhesitatingly obeyed, as such orders would be by soldiers. The system worked well in Germany. In England it was different: the foreman would often argue the matter with him, and eventually perhaps not carry it out precisely as he had desired. But, he added, "I am not quite sure that I do not prefer the English system—it is more human." I think most of us would be inclined to agree in this; and it might be interesting to inquire whether there was any connection between this educational system and the extreme socialist opinions which find expression in some foreign States.

What now are the means for a general public audit—if I may so say—of this very large expenditure of time, money, and energy: how are the general public to satisfy themselves that the most is made of the means at the disposal of the country? As far as concerns the Government-aided schools of science and art, we have the examinations and inspections of the Science and Art Department, and its inspectors have instructions to aid local authorities whenever they wish it, as far as they possibly can, with advice and assistance. The admirable examinations in technology of the City and Guilds of London Institute afford a means to local authorities for judging of the work of their schools in that class of subjects in relation to what is being done in the rest of the country. The Institute also inspects classes throughout the country at its own initiative or on the application of county councils, though it only now makes payments on results within the metropolitan area. But neither the inspections nor the examinations would appear to be taken advantage of to anything like the extent we might expect. Thus only 218 classes were inspected last year, while the total number of individual candidates examined was only about 11,600.

The Society of Arts holds examinations in a large number of commercial subjects; but these, again, were only held in 11 subjects at 144 centres, and attended by 4,739 candidates.

There are no doubt other examining bodies, but I think I have said enough to show that there is room for and need for some central organisation to which local authorities may appeal for assistance in examination and inspection and advice *when they wish for one or the other*. In saying this I hope I may not be supposed to cast any slur on the admirable staffs which local authorities are creating for the superintendence of their technical instruction. But their work and experience are necessarily restricted locally. Comparison and experience gained elsewhere may be of the greatest use to them; while the support of an outside organisation may often be most desirable. Nor do I wish to ignore the exceedingly valuable work done by the National Association for the Promotion of Technical and Secondary Education by means of its "Record." This must be of the greatest use to local authorities by furnishing them with information as to what is going on in different parts of the country. But the Association does not examine or inspect.

Under the impression that something was wanting the Council of this Society — the Society which has interested itself in such questions far longer than any other—called a Conference to consider the matter last June. In accordance with the wish of the Conference a large and influential committee has been appointed which will meet shortly, and I trust its labours may lead to a good result. It is certainly not the wish of the Council to interfere with, or to do anything to conflict with, the operations of any other examining body, still less to clip its wings if it desires to take a wider flight. All that the Council is anxious for—and in this I am sure I express their feelings—is that by some means the various bodies should be brought into line, that there should be co-operation, and, if possible, co-ordination, and possibly that there should be —to use a word which is much to the fore just now—some form of federation. I mean, of course, among the examining bodies which are not State supported.

My strong interest in having this question brought to a successful issue has been in no way modified by what has occurred since it was first mooted. On the contrary, it seems to me to assume greater importance. All who are watching the trend of public opinion on the question must have seen it constantly broadly stated, and this not by irresponsible scribblers, but by men of light and leading, that the greater part of the money now spent on technical education is wasted. It is not for me to express an opinion on the subject, even if the materials on which to form a sound opinion were extant. They are not. It is the danger of public opinion being formed on insufficient data that the Council of this Society desire to guard against.

But as regards this asserted waste, there are one or two questions which it may be well to raise at once. What is waste in such an undertaking? Pedagogy is, or, perhaps I ought to say should be, more than it is, an experimental science and art. Now, as I remarked last year, it is of the very first importance that local authorities should have the utmost latitude in trying, for their own satisfaction, every experiment in technical instruction which commends itself to them as suitable to their local circumstances and conditions. In this way not only have they been enabled to satisfy themselves as to what was possible and desirable, which never could have been the case if they had been subjected to the control of a central authority, but the mere fact of having the question relegated to them has induced a large body of men of the world—unspecialised men, if I may so say—who would probably not otherwise have done so, to take a deep interest in this matter which so deeply concerns the community generally.

If, then, in the course of organisation unsuccessful experiments have been tried, are we to say that the money expended on them has been wasted? I cannot think so, any more than one would say that the money expended in a chemical or physical experiment is wasted when, from some unforeseen circumstance, no valuable direct result is obtained.

The other question is this. How far is money wasted in consequence of this technical instruction being offered to people to whom it is of no direct use—who will not themselves turn it to practical account? I do not wish to hazard an opinion. I would prefer to take refuge in the dicta of one of the early members of this Society, Dr. Johnson, who took great interest in it. In "Rasselas, Prince of Abyssinia," he is generally supposed to have given his views of education in its broadest sense. Rasselas, as you will remember, is a very proper young man, who desires to improve himself, and learn all that is to be learnt. He first aids the merchant to complete his flying machine. "In a year the wings were finished, and, on a morning appointed, the maker appeared, furnished for flight, on a little promontory; he waved his pinions a while to gather air, then leaped from his stand, and in an instant dropped into the lake. His wings, which were of no use in the air, sustained him in the water; and the prince drew him to land, half dead with terror and vexation."

The prince then finds "a man of learning"—Imlac—and pumps him—though probably Dr. Johnson would not have used that expression—as to how he acquired all his knowledge. Imlac, among other adventures, describes how he went to sea, or as he describes it, "entered upon the world of waters," and "amused myself during the voyage, sometimes by learning from the sailors the art of navigation, which I have never practised, and sometimes by forming schemes for my conduct in different situations, in not one of which I have been ever placed."

But I do not know that Dr. Johnson thought this time and money wasted; certainly Rasselas did not, for he immediately set out "upon the world of waters" on his own account.

I have now the agreeable duty to perform of presenting the Society's medals which have been awarded during the last session.

For papers at the Ordinary Meetings:—

To HIRAM S. MAXIM, for his paper on "Experiments in Aeronautics."

Mr. Maxim has, by his exhaustive experiments on this subject, proved conclusively the possibility of raising a heavy machine from the ground by means of the energy developed in the machine itself, which all must allow is a very real step towards solving the problem of aerial flight.

To THOMAS WARD, for his paper on "The Manufacture of Salt."

The full account of the sources of salt, and its manufacture in the salt districts of England, which Mr. Ward has given us, is of great value on account of the importance of this vast industry.

To GENERAL J. MICHAEL, C.S.I., for his paper on "Forestry."

The importance of forestry has been recognised by the Society of Arts from its first institution, and it was well that General Michael, to whom Indian forestry owes much, should here draw attention to the urgent need for carrying out in England principles which have been so successfully applied in India.

To PROF. VIVIAN B. LEWES, for his paper on "The Commercial Synthesis of Hydrocarbons."

Prof. Lewes brought to the notice of the Society a remarkable discovery, which is likely to exert a considerable influence in the future on our powers of illumination; and he exhibited, for the first time in England, the brilliant light obtained by the burning of acetylene, which was produced in the room from carbide of calcium and water.

To A. G. STANTON, for his paper on "Tea."

In this valuable paper Mr. Stanton brought forward a large number of statistics, showing the enormous growth in the production of tea in our great dependencies—India and Ceylon—which has taken place of late years.

To W. M. ACWORTH, for his paper on "Light Railways."

The need for further means of communicacation, such as would be provided by light railways in our country districts, has been widely acknowledged, and Mr. Acworth, who is an authority on the subject, brought forward much valuable information in this paper.

To J. J. HOLTZAPFFEL, for his paper on "Sand-blast Processes."

The great advances in the use of the sand-blast, since Mr. W. E. Newton read a paper upon this subject in 1875, were well set forth by Mr. Holtzapffel, who illustrated his paper with demonstrations of several of the remarkable applications for which the process is now employed.

To A. G. CHARLETON, for his paper on "The Dressing and Metallurgical Treatment of Nickel Ores."

Mr. Charleton, in 1894, read a valuable paper on "Nickel," which he followed up last Session with a very full and instructive account of the many processes for treating and preparing the metal.

In the Indian Section:—

To W. LEE-WARNER, C.S.I., for his paper on "Roman and British-Indian Systems of Government."

In his scholarly and thoughtful paper Mr. Lee-Warner contrasted, with great acumen, the Roman and British systems.

To CAPT. JOHN SHAKESPEAR, D.S.O., for his paper on "The Lushais, and the Land they live in."

We are indebted to Captain Shakespear for a most valuable contribution to the understanding of the little-known people, whose country has lately come within the national purview.

To C. KRISHNA MENON, for his paper on "Village Communities in Southern India."

In drawing attention to the survival of village communities, Mr. Menon urged the reform of rural life on the basis of existing communal institutions.

In the Foreign and Colonial Section :—

To Dr. A. Markoff, for his paper on "Russian Armenia and the Prospects for British Trade thereto."

This paper was of great interest, and gave in admirable English the experience of a Russian traveller in this little known district.

To Capt. Wiggins, for his paper on "My Recent Voyages in Siberia."

Captain Wiggins, who had previously described his voyages to the Yenesei River, gave an instructive account of his last adventurous journey, and again forcibly urged the opening np of this fertile district to trade.

In the Applied Art Section :—

To Mrs. May Morris Sparling, for her paper on "Mediæval Embroidery."

This Society always welcomes lectures by ladies, and I am pleased that a medal has been awarded to the gifted daughter of the distinguished poet and artist, Mr. William Morris, for her interesting paper, which was illustrated by some of the finest examples of an art in which our English ladies have always taken much interest.

To William Gowland, for his paper on "The Art of Casting Bronze in Japan."

Mr. Gowland's exhaustive account of the processes used by the Japenese from the earliest times should be of the greatest value to our own artists.

To Prof. W. B. Richmond, A.R.A., for his paper on "The Decoration of St. Paul's."

Mr. Richmond described his highly successful attempt to carry out the much-needed decoration of our great London cathedral, by the use of mosaic work, in accordance with the old Italian practice.

The thanks of the Council were also voted to the following members of the Council :—

To Capt. W. de W. Abney, C.B., F.R.S., for his paper on "Means for Mitigating the Fading of Pigments."

To Sir Charles M. Kennedy, K.C.M.G., C.B., for his paper on "Colonies and Treaties."

To Prof. W. Chandler Roberts-Austen, C.B., F.R.S., for his paper on "The Extraction of the Rarer Metals from their Oxides."

Prizes for Photogravure :—

The Society, with a view to encourage the art of photogravure in England, and to show English artists that as good work could be produced here as on the Continent, where they are in the habit of sending their pictures to be reproduced, offered two prizes, one for the best photogravure and the other for the best photographic negative from a selected picture in the South Kensington Museum. Both were to be absolutely untouched. The picture selected was the most difficult to render in the whole collection. I am glad to say that the result of the competition was in every way successful, and have now to present the following prizes :—

Prize of a Silver Medal and £20 for photogravure plate to Ernest A. Smith.

Prize of a Silver Medal and £10 for photographic negative to The Swan Engraving Company.

Mr. W. H. Preece, C.B., F.R.S., proposed a vote of thanks to the Chairman for the admirable address he had delivered. It was always a pleasure to hear a master discourse on his own subject, and life-long work had rendered General Donnelly a complete master of the subject of education, a subject on which most people were very ignorant. They got confused at the enormous number of names which were attached to schools, and the various classes of education. There were primary, secondary, and high schools, besides technical schools and many others; and they heard of elementary, secondary, collegiate, technical, and scientific education; and it was a comfort to find that a master of the subject had brought them all together, so that those who were anxious to understand all these terms could learn the meaning of them at their leisure by studying the columns of the *Journal* of the Society. One branch of the subject had not been alluded to perhaps quite sufficiently; he referred to the enormous efforts which were being made by institutions, private firms, and individuals, to do that which the Government was endeavouring to do, but had not quite succeeded in doing. Even in Government departments a great deal was being done which was not generally known, because it did not appear in published papers. He might speak of his own experience in the Government departments in which he was interested. There technical education was carried on to a very large extent, and it was very greatly aided by the grants from South Kensington, and by the rewards and medals bestowed by the City and Guilds Institute. But, apart altogether from this self-supporting kind of education, there was a great want in this country of that which was so evident in the United States—there was a great absence of patriotism in the matter of education. If this address should excite in the minds of those who had money to leave, a desire to leave some of it for educational purposes, it would do an immense deal of good. Only last week he read that an American, Mr. Rockefeller, had bestowed the equivalent of £200,000, to add to a previous gift of £800,000, making £1,000,000 altogether, towards the endowment of the Chicago University. There was no such thing known in this country. Some efforts had been made in some provincial towns, but they heard of rich men leaving millions behind them, and never giving a penny towards the cultivation of that field in which the Chairman was working so hard. He trusted this addresss would be read by some who would be tempted to follow the example set them in America, and do something for education without trusting entirely to Government support. The Chairman implied that the efforts of Government departments were not sufficiently appreciated; and it was quite true that those engaged in the public services did not expect to receive from the public or the Press medals or rewards, but he was quite sure that General Donnelly would receive from that Society its highest approval, and that the vote of thanks would be carried by acclamation.

Sir STEUART COLVIN BAYLEY, K.C.S.I., seconded the motion, which was put by Mr. PREECE, and carried by acclamation.

The CHAIRMAN briefly acknowledged the compliment, and the meeting adjourned.

Miscellaneous.

THE GERMAN MATCH INDUSTRY.

The manufacture of matches in Germany, which has risen to be an industry of great importance, employs pine, poplar, aspen, linden, and birch woods. Of these woods aspen has proved itself indispensable in the manufacture of matches by reason of its natural qualities and the ease with which it can be worked up. The flame of a match, as is well known, is conveyed to the wood from the igniting composition by sulphur, as in the case of lucifers into which the splints are dipped. In the case of some matches the sulphur is substituted by paraffin. The sulphur, where this is used, remains on the outside of the wood and dries at once. The paraffin however must penetrate into the wood partly because the matches would otherwise stick to each other, but principally because the paraffin becomes fluid again at even low degrees of heat and would penetrate the igniting composition and render it useless. For safety matches therefore a wood is required which has light and spongy pores, as found only in the aspen, whose bright white colour further gives it an agreeable appearance. Poplar has a grey colour and is brittle, birch wood becomes yellow and is seldom obtainable in stout logs. These woods are also slow of combustion. Pine and fir woods take up little paraffin owing to the resin they contain. The United States Consul at Annaberg says, that in order to keep the pores as open as possible, and to work up the wood to the greatest advantage, the aspen splint is produced by flaking. This flaking is done by causing a knife to revolve round a log which rotates on its own axis. The wood is divided into ribbons of the thickness and width of a match; these ribbons are laid evenly one above the other and cut into square splints. In consequence of the uniformity of the layers aspen wood produces perfectly homogeneous ribbons or splints. This is not the case when other woods are flaked. The absence of all grain further enables aspen wood to be flaked into thin shavings which are worked by other machines into the familiar matchboxes. Attempts have been made to flake fir and pine wood as substitutes for aspen, but it is not known that any results of importance have been obtained. Match manufacturers require that the aspen wood should be free from rotten pith and as far as possible free from knots—free from pith, otherwise the wood cannot be fixed in the flaking machine; free from knots because the wood round the knots is decayed. The aspen is available for matchmaking as soon as the trunk has a diameter of eight inches. The demand is greatest for trunks with a diameter of ten to twenty inches. To attain this size a period of twenty-five to sixty years is necessary, according to the nature of the soil, position, &c. Trunks from twenty to thirty-five years old are preferred to younger growths for the reason that the method of manufacture produces the same amount of waste whether the trunks be large or small. The match factories which use aspen wood are mostly situated in Silesia, Pomerania, Schleswig-Holstein, Bavaria, Rhine Provinces, Alsace Lorraine, Rhine Palatinate, and the Duchy of Anhalt. These factories use on the whole 4,000,000 to 5,500,000 cubic feet of aspen wood, of which about 350,000 cubic feet are imported from Russia. The Siberian factories, mostly through dealers, procure their wood from Upper Silesia, Poland, Galicia, and Hungary. To procure wood from the districts of Königsberg and Gumbinnen is unprofitable, because the freight is considerably higher than from Cracow or the Tatra. For the factories in Pomerania, the principal sources of supply are Riga, Koono Libau, Windau, and St. Petersburg, where dealers carry on a large trade. The wood is felled in the forests, brought down to the sea, and shipped when water communication is open. It is sold in the form of logs with both ends cut smooth. The ports through which aspen wood is imported are Königsberg, Danzig, Kolberg, Rügenwalde, Flensburg, Lubeck, Amsterdam, Antwerp, Stettin, and Bremen. The prices for Russian wood vary according as the wood comes, rafted or unrafted, to the market. The factories in Anhalt use native wood from the neighbouring forests, and Russian wood which comes *viâ* Stettin. In Alsace-Lorraine the wood is taken from native forests, but it is no longer very thick, and cannot be flaked, but must be planed. The stocks have been freely felled in the last ten or fifteen years, and no care has been taken to replace them. The factories of Schleswi Holstein procure Russian wood *viâ* Libau and

Königsberg. In the Rhine Palitinate Russian wood is used, and the factories of the Hundsrück use aspen wood from the forests of Nassau, Bavaria, and the Eifel. In Bavaria where the wood is also becoming scarce, native wood from Upper and Lower Bavaria is used. The rapid decrease of the native stocks of the aspen, and the subsequent enhancement of the prices of this raw material, together with the difficulty of obtaining it, led a number of Chambers of Commerce to memorialise the Minister of Agriculture and Forestry, and to petition him to cause the foresters, in whose districts match factories are situated, to pay more attention to the growth of the aspen. A similar representation has been made by persons concerned to the French authorities. The Russian manufacturers, seeing their advantage over their German and French colleagues, were not slow in petitioning their own Government to prohibit the exportation of aspen wood.

POPULATION OF CANTON.

The following particulars are taken from the *North China Herald* of 5th July last;—

In a recent census taken by order of the Viceroy at Canton, the inner and outer cities are shown to contain 481 streets and lanes, 24,962 houses, 233 temples, 107,035 males, and 53,975 females. The eastern suburb contains 123 streets, &c., 7,627 houses, 61 temples, 23,738 males, and 14,812 females. The western suburb contains 875 streets and lanes, 43,942 houses, 226 temples, 192,249 males, and 87,355 females. The southern suburb contains 65 streets, 3,476 houses, 33 temples, 13,372 males, and 6,402 females.

Altogether there are 336,754 males and 162,544 females, 80,007 houses, 1,544 houses, and 553 temples. There is also the boat population, which, 60 years ago, numbered 80,000, giving, at three persons per boat—much too low an average—a population then of 252,000. This number must be now largely increased, and 350,000 to 400,000 would probably be nearer the mark—children are not included probably. This brings up the population to 1,000,000. In 60 years this population should nearly have doubled itself, and the estimate now given by foreign observers is 1,800,000. A poll tax is levied on persons without house property, and there is a tendency to underrate the number of persons avoiding taxation. The great discrepancy between male and female population is noticeable. It is ascribed to the fact that the wives and families of most of the workers live in the neighbouring country villages. The women live in cheap houses in the country, and the girls stay with their mothers till they are betrothed, and then go to their mothers-in-law. While men abound in cities, the village populations are chiefly female. Representative male heads of families live in the villages, and there is sufficient adult male labour to cultivate the fields; the brothers and sons go to the city.

Canton is a city of workshops, printers, carpenters, workers in lacquer ware, sailmakers, silversmiths, braziers, workers in ivory and tortoise-shell, painters on glass, on paper, and on silk; glass blowers, firework-makers, mat weavers, cloth weavers, embroideries, paper-makers, sugar refiners, fan-makers, carpet weavers, makers of china ware, of grass cloth; and jade stone turners. Of all these trades, women only are engaged in embroidery. In addition, men in China cook, run errands, sweep floors, and wait at table. Women only do the washing; hence the marked preponderance of males over females in the city. It may be added that life in the country is much more moral than in the cities, chiefly owing to the family institution being in full operation in the villages.

AGRICULTURAL INDUSTRIES OF ANGORA.

The methods of cultivation in Angora are most primitive, no advance having been made in the introduction of improved implements. Moreover the wasteful mode of sowing and threshing considerably reduces the net profit of each acre of land. The ploughs are made entirely of wood, except the share and coulter. Often nothing more than a carved branch of a tree with a piece of iron as its share is met with. The yoke is long owing to the necessity of avoiding too great pressure of the weak machine against the obstacles it is liable to encounter and which the ploughman does his best to avoid. Consul Cumberbatch says that the use of the harrow is unknown. The seed is generally sown broadcast after the second ploughing and the third ploughing covers it with the furrow. By this mode of operation it is held that the seed that does get covered up is better protected from the long hard frost of winter. In cutting the wheat and barley the old-fashioned scythe is employed. The separation of the wheat grain from the husk and the manipulation of the straw are effected by a flat threshing board, armed underneath with short thick teeth of flint, being drawn over the outspread crop by a pair of oxen, the tread of whose feet materially helps the operation. The spade has a handle longer than the height of man, and a bit of wood projecting a few inches above the blade, so as to permit of the foot being set upon it, in order to propel the blade, which is sharp, farther into the soil. The length of the handle enables the digger to lay his whole weight upon the extremity and afterwards to use it as a lever to raise a large quantity of soil, which he merely turns over. The hoe has a broad blade, not flat, but slightly concave, enabling it to hold a good quantity of soil. Numerous attempts have been made from time to time by foreign agencies to introduce agricultural machinery of European or American make, but although the advantages of machinery have been clearly shown they have been unsuccessful. The Turkish agriculturist has a great aversion to changes of any kind, and he is likewise unable to make any considerable outlay for the purpose of expensive implements. There is no fixed plan followed for the rotation of crops. As there is much fertile land at the disposal of the husbandman, he after sowing the same crop consecutively in one field, lets it lie fallow for a year or two as soon as he finds the earth has lost its strength; in the meantime he works a new piece. Irrigation and drainage, as understood in Europe, are unknown. Vegetable gardens are irrigated with water from a neighbouring stream, and suitably placed fields are flooded occasionally so long as the water lasts. Wheat takes the first place in the list of cereals grown in the province. The three kinds best known to commerce are *goundouru* (hard), *sumter* (hard, of a smaller size), and *gadiroglou* (soft). The average annual crop is estimated at 8,000,000 bushels. The usual rate of sowing is from two to three bushels per acre, according to the nature of the soil, and the average net return is five-fold, though in favourable soils the yield reaches fifteen-fold in unusually good seasons. A bushel of Angora wheat weighs from 56 to 60 lbs., and the yield of flour 47 to 48 lbs. per bushel. Bread made from the flour of hard wheat contains a small per-centage of sharps, which gives it a rather darker colour than the bread made at Constantinople. It resembles English farmhouse bread, and is more nutritious. Barley comes next in importance, and although formerly only grown in sufficient quantities to meet local requirements, an export demand has arisen since railway communications have been established, and the annual crop now reaches over 3,000,000 bushels. Barley yields a comparatively better crop than wheat. The kind most extensively grown is the white sort, but there are two other qualities produced on a smaller scale, one being black, and the other a naked or stript barley easily confounded with wheat, and called *Peighamber bogdai*. Linseed is having more attention paid to its cultivation owing to the increased transport facilities, especially in the Kir-Sheir, Keskine, and Ak-Dagh districts, which are suitable to its growth. Rice of excellent quality is grown in the western districts of the Sandyak of Angora, but is dependent upon water which is not always unlimited in its supply. Owing to low prices, its fickleness and dependence on the weather, opium does not allow much profit to the local farmer. Its commercial value has also been depreciated, on account of extensive adulteration, and its place is being gradually taken by wheat and barley. The best quality comes from Tchiboukabad, and the inferior, from Yozgat. Cotton is cultivated for the needs of the peasant, who makes his clothes and bedding from the raw material. Rye is cultivated in the Cesarea district, and oats are grown on a small scale for feeding oxen and buffaloes. Sesamum is to be found in small quantities at Bey-Bazar, Nallihan, and Mihalidjik. In the vicinity of large towns, extensive kitchen gardens are profitably worked, and the commoner kinds of vegetables are largely grown. In addition to grapes, which are treated separately, the various kinds of fruits are as follows:—Apples, apricots, cherries, chestnuts, mulberries, peaches, pears, plums, quinces, and walnuts. The Angora pears, particularly the winter varieties, are well known on the Constantinople market, as well as the apples called "English," because originally introduced some two hundred years ago by resident members of the old Levant Company. They are of large size and delicate flavour. The vine is cultivated all over the province —in the vicinity of towns—but it is not generally looked upon as a source of revenue. The area of the vineyards varies from a quarter of an acre to twelve acres, according to the wealth of the proprietor; whilst the total area planted with vines is estimated at 75,000 acres, producing annually about 700,000 cwts. of grapes of 36 varieties—10 red and 26 white, including the famous *Tchaoush*. The superiority of the grape is undoubted, the alcoholic strength being from 13 to 17 degrees. Owing to the low market price of grapes, consequent upon the non-exportation of that article and the absence of any large wine manufacturer, no pecuniary profit is derived from vineyards; but as the proprietors make wine and distil spirits for their own use, besides manufacturing various kinds of preserves, the chief of which, *petmez*, is a great article of food among the Turks, they in one way or another get a return for their outlay. *Kitré*, or gum tragacanth, is a partially soluble gum obtained from a species of astragalus. It is known in commerce as fine white "Syrian" tragacanth, and appears as "leaf," "sorts," and "vermicelli." It has the appearance of twisted ribbons, is white and reddish, nearly opaque and slightly ductile. Its adaptability in lieu of borax for giving a lustre to starched linen is perhaps not generally known. The districts where the shrub is chiefly found are Yozgat, Iskilip, Cesarea, Kaledjik, and Angora. The yellow berry, the fruit of a species of buckthorn, having been formerly an article of export of great value for dyeing purposes, much labour and expense was at one time bestowed upon its culture, but the universal use of chemical dyes has reduced its demand to less than one-fourth and its value to one-tenth of what it realised twenty-five years ago. Cesarea is the principal centre in which it is grown. As regards other native products, the wool of the Angora sheep is produced annually to the extent of about 37,000 cwts., one-half of which is used locally in the manufacture of carpet and wearing apparel, and the remainder is exported. About 90 per cent. of the wool is known to commerce under the name of *Vakit*, which represents the annual spring clip of sheep, and 10 per cent. is the autumn clip of the lamb, and is called *Guz-yongnou*. The average annual clip of the famous Angora goat reaches 30,000 cwts. The mohair is purchased by local merchants from the owners of the goats in its unwashed state, frequently several months before the shearing season (April). It is sorted in the warehouses into four classes called "whites," yellows," "colours," and "inferiors." The "whites" are not washed, but are at once packed into sacks to be exported at the favourable moment. The "yellows" are sent to the nearest river to be washed. Though the "whites" are supposed to be packed separately, a scrupulous attention to this matter is not the rule, and Consul Cumberbatch says that this gives rise to serious complaints from Bradford and other purchasing centres. An attempt is being made to increase the rearing of silkworms in the Kaledjik and Nallihan districts, though the annual crop of cocoons is still small. These are sent to the Broussa and Biredjik factories in their raw state. In consequence of the vast pasture lands, the rearing of animals takes a prominent position in the rural economy of Angora, and the principal wealth of the inhabitants consists in their live stock, and the produce they extract therefrom in the shape of mohair, wool, hides, and skins.

General Notes.

University College. — A series of evening classes have been arranged at University College, Gower-street, in conjunction with the Technical Education Board of the London County Council. The subjects are—Mechanical engineering, on Monday evenings, 7 to 9.30 p.m.; electrical engineering, on Tuesday evenings, 7 to 9.30 p.m.; applied mathematics, on Thursday evenings, 7 to 9 p.m.; and technical chemistry, on Friday evenings, 7 to 9.30 p.m. These courses are intended for students who have by attendance at other classes already reached an advanced stage in their technical work. The courses of instruction will afford an opportunity to students who can study only in the evenings to obtain instruction in well-equipped University laboratories, and will make available to evening students the same advantages as are enjoyed by University day students.

Immigration into the United States.—The report of the Superintendent of Immigration in the United States shows that the arrivals of immigrants during the year 1894 numbered 288,020, 2,389 of whom were debarred from entering the country, and returned to their respective countries at the expense of steamship companies. The number not admitted includes 1,533 who came under contract made previous to arrival, to perform labour in the United States. There were also returned 417 who became public charges within one year after arrival. A great decrease in the volume of immigration, as compared with recent years, is shown. In 1893, the arrivals numbered 440,783, which was a decrease of 141,044 from the previous year, while the reports for the last fiscal year show a further decrease of 152,763, or 293,807 less than in 1892. In 1893, the decrease was caused mainly by the suspension of immigration on account of cholera. The decrease last year was attributed largely to the general business depression, which produced a condition of affairs not encouraging to classes seeking new and better homes. Russia and Poland contribute the largest per-centage of decrease, which is due partly to the fact that Russia has now ceased to execute its edicts against the Jews, and to the extensive colonisation of that people in the Argentine Republic, under the direction of Baron Hirsch.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 25...Scottish Society of Arts 117, George-street, Edinburgh, 8 p.m. Mr. James M'Donald, 1. "An Improved Oil Blast Lamp." 2. "Portland Cement and Concrete."
Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Walter B. Harris, "Amongst the Persian Kurds."
Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. R. M. D. Saunders, "Landlords and Tenants in Ireland."
Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. Karl Grossman, "The Færoe Islands."
Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.
Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. F. Seyton Scott, "Daylight Enlarging."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Augustine Birrell, "Dr. Johnson."

Tuesday, Nov. 26...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Mr. James Henry Greathead, "The City and South London Railway: Subaqueous Tunnelling by Shield and Compressed Air."
Photographic, 12, Hanover-square, W., 8 p m. 1. Mr. W. Ethelbert Henry, "A Demonstration of Photo-ceramics." 2. Mr. Valentine Blanchard, "A Method of Carbon Printing without Transfer."
Colonial Institute, Northumberland-avenue, W.C., 4½ p.m. Mr. W. S. Sebright Green, "Colonisation and Expansion of the Empire."

Wednesday, Nov. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. H. Cunynghame, "Locomotive Carriages for Common Roads."
Royal Society of Literature, 20, Hanover-square, W., 8 p.m.
British Astronomical, University College, W.C., 5 p.m.

Thursday, Nov. 28...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Prof. W. Boyd Dawkins, "A Forest Primeval."
Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. F. Bathurst, "The Electric Wiring Question." 2. Mr. Sam Mayor, "Concentric Wiring."
Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Henry Blackburn, "The Value of a Line."

Saturday, Nov. 30—Royal, Burlington-house, W., 4 p.m. Anniversary Meeting.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 27, 1895; Sir FREDK. BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Johnson, George William, 47, Lincoln's-inn-fields, W.C.

Moore, Alexander William, Great Western Railway, Bristol.

The paper read was—

LOCOMOTIVE CARRIAGES FOR COMMON ROADS.

By H. H. CUNYNGHAME.

One of the most satisfactory changes of public opinion that has taken place within the last 50 years is the disappearance of that dread and even hatred of machinery, which once distinguished the majority of the inhabitants of this country.

I am not now about to discuss the advantages or disadvantages of the introduction of mechanical power. It has been urged that machinery has destroyed art and healthy country life; and Ruskin has gone so far as to define a railway as a contrivance for taking a fool from a place where he had better stay, to another which he had better not go to.

There is much to be said for the view that manufacturing industries have damaged art, and have driven the population of the country into the squalid streets and alleys of towns. On the other hand, there can be no doubt that the great rise of money wages, and the cheapening of commodities which has taken place in the last 80 years, has been principally due to machinery.

In the earlier days of locomotives, it was not unnatural that they should meet with opposition. They offended those who gloried in our splendid breed of horses, to whom no music was like the cheerful notes of a coach-horn, and no sight so welcome as a spanking team coming rattling in to a stage at 20 miles an hour, the steam rising from their flanks and the mud splashing away behind them.

But railways have by no means destroyed the breed of horses, and it will I believe be found in the future that all who can choose, will prefer to handle the ribbons over a pair of bays rather than to twist the handles of a steam-engine, and that horses are not to be extinguished, and never will be.

But it will also be found, I think, a great advantage to the agricultural community to have a cheap and certain method of bringing their wares to market, and to our young men in towns another means will be provided, not of making solitary excursions into the country, but also of taking their wives, and perhaps their sweethearts with them.

And if in the future we no longer see the sorry spectacle of poor jades of horses that have once seen better days trudging in their old age through sleet and mire along the slippery streets, we shall not see the cabmen idle; on the contrary we shall I believe see smarter cabs, reduced fares, and a better living for the men got out of them.

I do not propose to go through the history of road locomotion, partly because the subject has been admirably dealt with in an excellent work by William Fletcher, and published by Spon in 1891; partly, also, because the history of steam road locomotion is to be dealt with exhaustively in a series of Cantor lectures within these walls. I shall, however, say a few words upon the history of the subject only so far as is necessary to illustrate the considerations which I propose presently to lay before you.

It is believed that the first idea of a steam locomotive is due to Sir Isaac Newton, who proposed to mount upon wheels a kettle with a spout with a very fine orifice, the jet of steam from which should blow it along in the same way as a rocket is driven forward. But we have no proof that it was ever made.

Various steam carriages were constructed in the last century. One of the earliest of these was by Cugnot, whose machine is still in the Arts et Métiers in Paris. But his countrymen seem to have been unable to decide whether to treat him as a prophet or a martyr, for, in using it in 1770, he had an accident, and was sent to the Bastille. He was then released and pensioned. He lost his pension during the Revolution, but it was restored by Napoleon.

The next attempt at a locomotive was by Murdoch, a workman in the factory of Boulton and Watt. He had applied for employment, and been refused, when Mr. Boulton looked at his hat, and asked him to show it. It proved to be a specimen of elliptical wood turning, by means of an original machine. He afterwards became foreman in the works. His little car was made in 1781, and ran on the roads and lanes, but it was not carried beyond the experimental stage.

From 1801 onwards, almost every single year produced a new steam carriage. In type they were somewhat similar, though great variety of invention was shown in the construction of the boilers. Among them, the name of Trevethick is pre-eminent as the advocate of high-pressure steam. The real difficulty which existed at that time seems to have been to realise the fact that you could make a carriage move—not by pushing or drawing it, but by sitting in it and twisting the wheels round. Want of faith in this fact gave rise to the invention of several machines on wheels, but furnished with huge legs, like those of a gigantic grasshopper, moved by steam, which kicked the carriages onwards.

By the year 1820, these fancies were abandoned. It became recognised that the proper way to drive a carriage onwards was by twisting the wheels round, and from that time invention progressed rapidly. I shall presently show upon the screen one or two of these attempts, and merely say that they culminated in 1834 in the machines of Hancock, Russell, Redmund, Roberts, and Hill.

All these were attempts to run carriages by steam upon common roads. But meantime, the question of steam tramways had been developed into railways, which so far eclipsed their rivals as to discourage the makers of steam road coaches, and throw all the energies of the nation into railway work. The first practical successful making of railways dates from the year 1830, not that the road engineers were without a knowledge of the benefit of rails, for several inventions were proposed of road-cars which, running on rails, laid them down continuously in front and took them up again from behind. And, even in 1821, David Gordon, carrying this idea to its legitimate conclusion, put a locomotive on wheels to run on the inside of a huge roller, like a squirrel in a barrel, and thus proposed to roll along the roads, pushing a two-wheeled cart before it. The idea of a loose barrel or rail has now, however, been abandoned, as it is, of course, easier to apply the force directly to the axle of the barrel itself.

From 1840 to 1857 nothing appears to have been done in road-carriages, but in 1857 the interest in the question again revived, and several excellent light road engines were made, one of which, belonging to the Earl of Caithness, will be presently shown on the screen.

But the progress of invention in the direction of light carriages was soon to be nipped in the bud. In 1859 a committee reported upon locomotives on common roads. I cannot find that they took any account of light road locomotives. One remarkable piece of evidence given was, that it was only machines which glittered with bright metal that frightened horses; when the glitter was painted black they did not mind.

In 1861 the first Locomotive Act was passed. This Act provided that every locomotive not drawing a carriage should have the tyres of the wheels not less than three inches wide. The locomotives were to consume their own smoke, and to have two drivers, the speed was not to exceed ten miles an hour, and all rights of treating these machines as nuisances were carefully preserved.

In spite of this draconian law progress continued to be made. Fisher and Richett made carriages that ran well on roads. In 1863, however, a further burden was placed upon the industry. The number of persons required to drive the locomotives was increased to three. It was required that a man should precede them with a red flag, and the maximum limit of speed was reduced to four miles an hour. Moreover they were forbidden to blow off steam even when they stopped to allow other carriages to pass. Now everyone knows that a steam-engine which stops must get rid of its steam somehow, so that this regulation compelled them either to break the law or burst. It is only fair to say that the severities exhibited to road carriages by the Legislature were equalled by those which it displayed towards railways. For the early engines were forbidden to work at more than 30 lbs. of steam pressure or to go at more than 12 miles an hour. These restrictions were, however, in the case of railways soon removed.

This Act destroyed the manufacture of light road locomotives. Those that were made were only made for export, and invention was entirely diverted in the direction of heavy locomotives proceeding at a slow speed, and thus the nascent industry came to an end. During the succeeding period some spasmodic attempts were made at high speed road locomotives on a small scale. In 1868 Mr. Knight, the well-known inventor of the "Trusty" petroleum engine, made a small carriage.

In 1881 Sir Thomas Parkyn, who died this year, employed Mr. Bateman to design and make a steam tricycle for him on a small scale. Mr. Bateman made a very ingenious boiler which condensed its own steam and thus proceeded without the escape of vapour and with but little noise. But Sir Thomas Parkyn was not allowed to use his carriage long. In 1881 he was convicted before a metropolitan magistrate and fined 1s. A case was stated and referred to the Divisional Court, which reserved judgment and gave a written decision, holding that the tricycle, though it could be propelled by the feet as well as by steam, was still a locomotive, and therefore had infringed the law by the absence of the red flag, the breadth of wheel tyres, and the other conditions.

I have the pleasure to say that Mr. Bateman is here this evening, and has, for this occasion, kindly collected and put together the shattered remains of his tricycle. It will be set to work here, and will get up steam in a few minutes. But the condensing apparatus has been lost. I will leave Mr. Bateman presently to point out the features of this engine.

There will now be thrown upon the screen some of the road-cars which have been mentioned up to this point.

When the applicability of electricity to ordinary household use had been rendered an accomplished fact by the labours of Gramme and Faure, it was not long before it was proposed to apply it to tramways. It has been very successfully used for this purpose. But its use for common roads locomotion has presented far greater difficulties. You cannot create energy, you can only transform it. Hence the electricity which lights our houses is only a form of energy derived from coal, which, in its turn, was collected from the heat of the sun by plants millions of years ago. Therefore in an electric car, you must either feed your electrical energy into the car as it goes, or else you must store it up and carry it along, just as a locomotive carries its coal.

Unfortunately, all attempts to turn heat into electricity directly have as yet proved abortive except as mere scientific toys. There is no mode known by which you could carry coals and burn them on the way, and directly convert the heat economically into electrical energy. If only the problem could be solved, all other forms of engine would probably soon become obsolete; and it is not impossible that it may be done.

Meantime, till this great feat is accomplished, all that can be done is to burn the coal, boil water with it, and produce steam; by means of the steam produce pressure, which, in acting, produces motion, which is used to whirl wires of copper in the vicinity of powerful magnets, and thus set in motion the "electricity" within these wires; this electricity is then conveyed into wires placed around moveable pieces of iron, which it converts into magnets, which are then pulled towards other stationary magnets, and circular motion is produced. This electricity can be stored, or, at least, can be made to produce such chemical changes in materials, as when they are reversed to reproduce it. This is done by passing it into large plates of lead immersed in dilute sulphuric acid. A number of these contained in cells of glass or wood are termed accumulators or storage batteries, and, if charged, will give back a great portion of what they have received. Unfortunately, however, they are very heavy, and, in the case of road cars, their weight is a serious consideration. For a road carriage we want a storage (say) of 1½ or 2 horse-power for 10 hours. A horse-power is about 700 watts, which would be afforded by (say) 30 accumulators, giving a current of 22 amperes. The weight of these would be about 1½ tons, which would have to be added to the load in the carriage. The carriage would thus have practically hardly any carrying capacity, unless it were made into an omnibus, and the storage power increased to three or four times the above amount.

A company in London—The Pioneer Electrical Carriage Company—has recently caused to be constructed an omnibus driven by electricity stored in accumulators. The results attained are said to be very good. Though having to carry a great burden of accumulators, this disadvantage is more than counterbalanced by the freedom from loss of power in gearing, the power of varying speed, and cleanliness, silence and safety. But I am not aware that any quantitative results have been published

In America several electric road-cars have been made. Among these may be mentioned the electric waggon of Morris and Salom. The weight of the vehicle is a little over two tons. It can travel about fifty miles without being recharged, at a speed of 15 miles an hour on the level.

Messrs. Garrard and Blumfield, of Coventry, have also made an electric road-carriage which weighs about half-a-ton, running upon wheels with pneumatic tyres. It has 24 accumulator cells, weighing about 22 lbs. each, and which are capable of developing half a horse-power. The machine can apparently run at a speed of 10 miles an hour on a perfectly smooth road, but a carriage weighing half a ton, and driven by so small a force, could hardly have much hill-climbing power. Mr. Garrard appears also to have invented a petrol tricycle, which I shall describe presently.

It has been narrated how the attempts to manufacture light steam road locomotives came to an end in England. On the Continent, however, they were continued. The most remarkable of them was that of M. Serpollet. A detailed account of it will be found in a report upon it by Mr. Hirsch, published in Paris in 1894. It was exhibited in 1889, and one was placed upon a tramway in Paris. The same design was subsequently adapted as a road car. The boiler is composed of tubes squeezed inwards; they are heated almost red hot, and water is then introduced by driblets, which is instantly converted into steam. The engine can be stopped simply by discontinuing the supply of water.

The idea of using very hot boiler tubes is an old one, but the practical difficulty of keeping them from being burned is an obstacle to their use. I have, with some success, prevented the burning of very hot iron tubes by surrounding them with thin platinum foil. It is possible that this method might be used for boilers.

Many other steam road-carriages have been made and used, a few of which will be presently projected upon the screen. But, in this connection, it is impossible to pass over the very extraordinary development of light boilers, due to the inventive genius of Mr. Hiram Maxim. The boiler consists of an enormous number of copper tubes three-eighths of an inch in diameter, and one-fiftieth of an inch thick, and has 800 square feet of heating surface, capable of evaporating about 16,000 lbs. of water into steam in an hour. This boiler is heated by gas vaporised from naphtha, the vaporisation being effected by the ignition of a little naphtha, which leaks out from the boiler. The steam, when used, is condensed into water, by being passed into flat tubes, which are kept in contact with cold air by the onward rush of the machine. So efficient is this arrangement that Mr. Maxim reckons the weight of the boiler, motor, condenser, tank, and all, when filled with water, at about 11 or 12 lbs. per horse-power.

At present most of the light carriages in use are driven by petroleum motors, but I cannot help believing that, in the future, steam will play a considerable part.

The great advantage of steam as a motor is its non-liability to get out of order, and, above all, the ease with which, by merely shutting off the valves, the speed may be completely controlled. In properly constructed boilers steam ought to be got up easily in about five minutes, and when it is desired to stop the engine all that is needful is to stop the circulation of water, when the generation of steam will immediately cease. If he will turn his mind to it, I cannot help believing that Mr. Maxim will have something to say towards the solution of this problem.

Among steam-engines must also be classed those engines in which, not steam, but the vapour of some spirit or oil is used. The advantage of these is that the liquid vaporises at a low temperature, and has but small specific heat, that is to say, it absorbs but little latent heat in its transference from a liquid to a gaseous form.

Naphtha is often used for this purpose, and some years ago American naphtha-engines were introduced for steam launches, but they became unpopular owing to the smell which proceeded from them. They are, however, lighter and more economical than engines driven by steam, and the steel parts in them are less likely to rust.

I next pass to petroleum-engines as motors for road-cars. The action of these depends upon the intimate mixing of air with a small quantity of petroleum vapour. This is then ignited, frequently by the electric spark, and a mild form of explosion occurs which impels the piston.

Petroleum is used in two different forms, either in the heavy oil, such as we burn in ordinary lamps, and which will not ignite if a match is applied to it, and the light oils, which are so inflammable that they will take light even if a match is held six inches away from the surface. So far as considerations of safety are concerned, the heavy oils are preferable, but hitherto they have been out of favour for steam launches, owing to their abominable smell. Mr. Otto, of New York, is said to have invented a method of deodorising naphtha. Among the road-cars driven with heavy oil may be mentioned that of Mr. Knight, of whose steam road-car mention has already been made. This excellent engineer, after constructing his carriage, commenced in October of this year to use it, but his fate was similar to that of Sir Thomas Parkyns, for about three weeks ago he had to make his appearance before the magistrates, and was fined. Indeed, the magistrates, under the existing law, had no option but to do so. His excursions on the road are now over, and he has to be content with a ride now and then round his own field. A photograph of his machine will presently be shown, and I am indebted to him for the loan of several of the slides used on this occasion.

We now pass to light-oil motors. Foremost amongst these may be mentioned the Daimler motor, now extensively used in steam launches on the Thames. This is a German motor, but two Paris firms are using it for their carriages, viz., Messrs. Pugeot, and Messrs. Panhard and Levassor.

The cylinder acts upon a heavily counterweighted crank, the whole being enclosed in a thin iron case through which the shaft protrudes, making about 700 revolutions per minute. Here, however, the disadvantage of all petroleum-engines appears. It is impossible to vary their speed, or at least possible only within such narrow limits as to make the speed almost invariable. The consequence is that it is only possible to make them go slowly by means of contrivances for gearing them down. In some a belt and pulleys are used; in others cogwheels are employed, and it is necessary to shift the cogwheels.

In all gas-engines considerable heat is generated, and therefore it is necessary to cool the cylinder. The carriages carry with them about 35 quarts of water for this purpose, which must be renewed every two hours. This, of course, occasions a loss of power. I have always wondered, whether a small refrigerating machine could not be attached to these engines so as to utilise the waste heat and cool the engine. I understand that an idea analogous to this has been introduced into the machine of Mr. Pennington, in America, about which I shall have something to say presently.

The carriage of Mr. Roger has a far lower rate of speed, being worked with a different petroleum motor, of which the cylinder has, of course, a larger diameter.

Not many of these petroleum carriages have come to England. The first to arrive belongs to Mr. Evelyn Ellis; the next to Sir David Salomons. All these machines are started by giving a few turns to the engine by means of a crank till it starts off. When you desire to stop, you disconnect the engine, letting it rotate. This causes an intolerable vibration, and none of them are free from it.

There are two methods of lessening this vibration—one by balancing the boiler and engine very carefully; the other by not letting it run idle, but by giving it work to do by the application of a brake, which absorbs its superabundant energy. This latter plan is being tried by Sir David Salomons, whose well known engineering ability, added to the resources of a splendid workshop, is endeavouring to solve the difficulty. I should have been able to show you his carriage here to-day, but unfortunately the doors of this institution are so narrow that it was computed that no amount of turning and twisting would get it in. I am therefore sorry to have to ask you to be content with a photograph.

To our neighbours the French is due the credit of reviving interest in these carriages. They have in this respect acted as pioneers in making scientific facts practicable, just as in the case of the dynamo and accumulator.

Owing to the enterprise of the editor of the *Petit Journal* a race was organised in France of 700 miles, from Paris to Bordeaux. A great number of carriages entered for it. The Panhard-Levassor carriage came in first, but in accordance with the conditions of the trial the carriage of Mr. Pugeot won the prize, as it had conveyed four persons instead of two. Both were driven by Daimler motors.

I am bound, however, to say that as regards designs I think there is great room for improvement. I was surprised also to see that the cogwheels were simply made with cast teeth, and not proper epicyclic teeth cut from the solid, as is usual in our best machinery. Thus the rattle was much increased.

Hitherto the method of designing these carriages has been to take a carriage and fit into it an engine contrived for some other purpose. I am convinced that it will be found that this method is entirely erroneous. In order to obtain a good carriage it will be necessary to start from a fresh standpoint, and to design the whole machine *de novo*.

A successful carriage must be, in the first place, not liable to get out of order. This is the first requisite. Economy of fuel consumption is quite a secondary consideration. Everyone who works a small gas-engine knows that the cost of the gas is the least item of his expenses. One visit of a mechanic and his mate costs him as much as he would pay for gas for a month. In the next place the machine must be easy to drive, and the steering arrangement must be contrived so that on rough roads it is not jerked out of the hand. The machine should be silent and free from smell. Then it should be light; 35 quarts of water seems to me a very large quantity to be obliged to carry about simply in order to keep the cylinders cool. It should also be free from vibration, and the machinery so covered in as to be protected both from rain and mud.

Inasmuch as many different patterns of carriage will be required, broughams, victorias, phaetons, and gigs, it will probably be necessary to design the engine and wheels of a uniform pattern, but so contrived that any sort of carriage can at pleasure be fitted on to the frames, so that the owner may change his carriage if he pleases. In this way the motor parts will all be uniform, and can be turned out by machinery on a large scale. It is only in this manner that economy of manufacture can be hoped for.

The carriages should also be provided with stanchions in which shafts can be put, so that if the engine breaks down a horse may be harnessed to the carriage. These cars should all use distinctive lamps.

Not only have the French designed road-carriages, but they and the Germans have also attempted to make petrol cycles.

The first of these, I believe, in order of time, is a German bicycle by Messrs. Wolfmüller, a picture of which will presently be placed on the screen. One of these is to be seen fitfully appearing from time to time in the suburbs fo London, but the rider generally hurries along as if he knew the police were after him, andno one seems to know who he is.

I only know of one English gentleman who has ridden this very dangerous machine, viz., the enterprising sub-editor of the new periodical called the *Auto-car*, and who, I suppose, felt in honour bound to try it. If it fell with the rider, I do not see how it could fail to break his leg.

The second petroleum cycle is the invention of Mr. Pennington, of New York. The engine runs at 500 revolutions a minute; the piston rod works directly on the hind wheel of the bicycle, which, therefore, is carried forward at about 500 yards in a minute, or 20 miles an hour. The fuel is ordinary kerosene oil, and the gas is ignited by the electric spark. It is claimed that this machine can, on a smooth road, go at the rate of a mile a minute. I believe that Col. Mellor, one of the directors of the South Eastern Railway Company, has ridden upon it.

Mr. Pennington appears to have also invented a bicycle driven forwards by means of an air screw propeller, which blows it along. But this method of propulsion is entirely contrary to principle, and it must be far more effective to apply the power to the wheels of the machine.

In a recent number of an American journal, entitled "The Horseless Age," a number of inventions are put forward which seem in the highest degree extravagant. In one of them a rider of a bicycle works treadles, which, however, instead of moving the wheel directly, work a pair of pumps, which pump water into a water-wheel connected to the hind wheel of the machine, and thus propel it.

There are also a number of road-cars propelled by spinal springs, which have to be wound up by means of winches. There are others which are propelled by primary batteries weighing 100 lbs., and having an output of 750 watts, that is to say, a horse-power for ten hours; in fact, so far as descriptions can be trusted, the number of these vehicles in America is very great, and their speed and performances altogether surpass anything that has been done in Europe.

A great competition was arranged for November 1st, at which prizes were to be given by the *Chicago Times Herald* newspaper. The first prize of £400 and a gold medal was open to all the world; the next, of £300, was, in the event of the first prize being won by a foreigner, to go to an American. The course was apparently about 92 miles in length, and lay near the shores of Lake Michigan. About 70 competitors were announced in the papers; of these two only started, and in consequence the race was postponed till November 28th, but as a great concourse of spectators had assembled a prize was got up for the occasion and won by a carriage built by Mr. Roger, of Paris, which I have already described. There is therefore no reason for English mechanicians despair, as soon as they can obtain statutory permission to try their machines on the common roads.

A more practicable instrument appears to be the tricycle. Of these the best known at present is that of the Comte de Dion who has brought one over to England, and which I hope to be able to show you. It is a very pretty little machine, and actuated by either the feet or by an electro-petroleum motor, or by both together. The engine is hardly powerful enough to go up steep gradients, but as a help to a tired cyclist it will be valuable. The Gladiator Company have also just brought out a petrol-tricycle, which is now at the Stanley Show at the Agricultural-hall. It is said to be capable of going 19 miles an hour on an asphalt road.

The editors of the *Engineer* are arranging for competitions in this country with prizes to the value of a thousand pounds. They have excluded from the competitions all carriages using light petroleum motors. This I think is a pity. It is best not to hamper enterprise, and the public would probably gladly have seen one prize reserved for this kind of carriage which is used so largely in France and has hitherto been successful in England.

It only remains to endeavour to make some sort of estimate of the cost of purchasing and using these carriages. It is probable that the initial outlay upon a carriage and horse is the same as that upon a first-class road-carriage. But the expense of up-keep and use is far less in the case of a mechanical carriage; for a carriage would generally use about 1½ gallons of petroleum a day, which at the highest price is 1s. 6d., and with this it will run easily 45 miles, a distance which no horse could accomplish. Supposing that a coachman and stable were necessary in each case, this reduces the cost of using a mechanical carriage to about half. The engine, also, is not likely to get ill, and will neither shy nor kick, and will not blow up or take fire, unless used very unskilfully.

I do not propose to offer any suggestions as to the course which legislation should take upon this subject. Either, as in the case of agricultural engines, the making of rules may be left to the various local authorities, or else —as in the case of cycles—it may be regulated by statute.

In the first case, there is danger of a multiplicity of discordant codes of rules, which it will be impossible to recollect; in the other, a statute will enact hard and fast rules, which it will be very difficult to alter.

Possibly some combinations of the action of local bodies, with the control of the Local Government Board, will afford the best solutions; in any case, the question of petroleum must be considered with the precautions to be observed in its use.

To Mr. Shaw Lefevre, the introducer of the Tramways Bills, is due the credit of having taken up this question in the last Parliament; for there can be little doubt that if Parliament shall see its way to remove the present restrictions, the foundations will have been laid of a great and lucrative industry.

The paper was illustrated by lantern slides of various machines, and by the exhibition and working of a stationary Daimter motor, also by Mr. Bateman's steam tricycle, and by the petrol bicycles of Le Comte de Dion, and of the Gladiator Company. The engines of these were made to work upon the platform.

Memoranda relative to Mr. Bateman's Steam Tricycle, p. 25.

The engine and the boiler had been put aside—all the other parts had been dispersed without thought of subsequent use. Most have, however, been found and put together, and the steam making, using, and condensing are fairly perfect.

The fans for forcing draught for furnace and cooling the condensing water cannot be found, and the liquid fuel furnace was long since broken up.

The boiler is to-night heated by an atmospheric gas burner of approximately the same power as the old benzoline furnace, which consisted of a cluster of 24 small burners. The steam gauge begins to move in 2½ minutes from first lighting with cold water, and in 4 to 4½ minutes stands at 80 to 100 lbs.

In the original benzoline burner or furnace, the rising of steam to a given pressure, 200 lbs., automatically turned off the supply to 18 out of the 21 burners, and these were turned on again as the steam pressure fell. The three burners always alight were the centres of three clusters of seven each, and kept the others hot enough to light up again directly the liquid fuel was again supplied.

A detailed description of the mechanism will appear in this week's number of the *Autocar*, the same having been supplied by Mr. Bateman at the request of Mr. Sturmey, the editor.

Mr. Bateman's old tricycle is in no sense a practical machine for to-day—many developments having taken place in the last 14 years—but simply of historical interest, and is exhibited to show some of the undoubted advantages possessed by steam over its numerous rivals.

DISCUSSION.

The CHAIRMAN said he had probably been asked to preside on this occasion in consequence of his connection with steam locomotion on common roads in days gone by. Gurney, Maceroni, Ogle, were all men who made steam carriages to run on ordinary roads, with more or less success. He could not include Russell, because his carriage was a discredit to engineering; and an explosion which occurred to it, killing several people, did a great deal to retard steam locomotion. But the one who did most of all was Hancock; and a further description of the boiler he used was worth giving. The Chairman then explained —with the aid of a diagram—the construction of Hancock's boiler, which had an extremely large heating surface, was very light, and perfectly safe. It supplied sufficient steam to drive a phaeton, which carried four persons, at the rate of 14 miles an hour. It partially condensed the waste steam, and the remainder was superheated, and given off, so as not to cause any visible cloud. There was no noise, and the carriage was absolutely under control. There was a foot brake, which was held down by the steersman, and entirely took the strain off his hands, only releasing it when he wished to move the steering wheel. The two driving wheels were loose on the axle, and were driven by a friction clutch, allowing about half a revolution in either direction. When moving in a sinuous direction, the inner wheel drove the carriage, and the outer wheel overran. To make a very sharp turn one of the wheels was thrown out of gear, and you turned with the other. The carriage would easily turn in its own length. The boiler was fired by coke urged by a fan blast; the wheels were on a second axle, and could be disconnected, and the engine used for urging the fire or feeding the boiler. Hancock, therefore, solved most of the problems of road locomotion; for many months his carriages ran from the Bank to Paddington and back, three or four times a day, at the usual 6d. fare; they stopped to take up and set down people when required, and had no difficulty in mounting Pentonville-hill, and often towed another carriage behind. Since 1840 road locomotion had gone back instead of forward, mostly he believed because it was taken up by men who were good engineers but very bad carriage builders. Occasionally, it was found that horses were a little bit startled by this steam carriage, but he never heard of any accident or bolting, and the omnibus horses on the road at the end of a week paid no more attention to it than to any other vehicle. He believed if the right sort of people had got hold of it the matter would not have been discredited as it was, and those Acts of Parliament would not have been passed which rendered any attempt of the kind absolutely impossible in England. Allusion had been made to the difficulty in one kind of engine of regulating the proportion of liquid to the power required, and of preventing the tubes becoming too hot, and in that connection he would call attention to Howard's quicksilver boat, as it was called. In that there was a boiler immersed in a bath of an alloy of quicksilver and lead, the temperature being regulated within certain limits by the proportion of the alloy. Water was injected into the boiler, enough for each half a revolution, and the way it was regulated was this; a cam moved a feed pump outwards, and it was brought back by a spring; by a set screw the length of journey of the pump could be varied to any degree, so that the exact quantity of water required was injected at each stroke. The boat worked for many months between London-bridge and Ramsgate. Reference should also be made to the little three-wheeled carriage of Mr. Loftus Perkins, in which a boiler working to 600 lbs. per square inch, was mounted on a single wheel, and turned with it as the car was steered. It worked perfectly, and condensed its steam by air condensation.

The Right Hon. GEORGE SHAW LEFEVRE, said he introduced a measure in the last Session for the purpose of removing the restrictions on horseless carriages, but, unfortunately, before the second reading a crash took place, his Government went out of office, and the Bill was lost. His own interest in the matter was first aroused by the competition in France some years ago, and when in Paris at the beginning of the year he went to Messrs. Panhard and Levassor's works, and was driven for some distance through the crowded parts of Paris in a horseless vehicle. He was convinced that they had, to a large extent, solved the difficulties. At any rate they had produced a carriage which could be used in the streets without difficulty or danger; and certainly what could be done in France could be done in England. Though the difficulties had been to a great extent solved, he did not think they had been completely so, and he believed it would ultimately be found that they would have to resort to steam rather than to petroleum, naphtha, or electricity. He was glad to see Sir David Salomons present, at whose instance there had lately been a competition at Tunbridge Wells, and also of the Comte de Dion, the inventor of a tricycle which seemed to be one of the most successful. It seemed monstrous that engineers and carriage builders should be prevented moving in this direction by an obsolete Act of Parliament. Some people thought that under a more recent Act of 1888 it would be possible to use these horseless carriages, but unfortunately that had been decided against them, and it was not without taking the best opinions that he introduced the Bill last Session. No one would be better pleased than he to find a new Act was not necessary, and possibly by going to a higher Court the present decision might be overruled. As it stood, however, a tricycle impelled by electricity had been held to be a locomotive within the Locomotive Act, and it must therefore be preceded by a man with a flag and could not be driven at more than four miles an hour. Whilst this was the case it was impossible for engineers to devote their energies to producing machines of this kind. He would suggest that the Society should organise a deputation to his successor at the Local Government Board for the purpose of inducing him to introduce a Bill to remove these restrictions. He believed they were on the eve of a most important movement in this direction. There need be no fear of the interests of the breeders of horses being injuriously affected, any more than they were by the introduction of railways, for there were more horses used now than ever.

Sir DAVID SALOMONS, Bart., said he would confine his remarks to a very few points, as he would have another opportunity of speaking at a meeting which was to be held at Cannon-street Hotel, on December 1st, to further this object. He was astonished at the want of commonsense displayed by some of our Judges. It was decided, in 1881, that a steam-tricycle, producing no noise, smoke, or other disadvantages, was a traction-engine. His contention had been that after the passing of the Customs and Excise Act of 1888, it was possible that a new meaning might be given to the word "locomotive," and that if anyone would have the courage to appeal from the magistrate's decision, the Court would somehow undo the previous decision by a side wind; failing that, they must go to the Court of Appeal. But if there was a speedy prospect of legislation it seemed hardly worth while to throw good money after bad. It was ridiculous to suppose that horse breeders would be injured, and, in any case, Lord Salisbury had said that protection could not be re-introduced in this country, that the people would not stand it; and to attempt to keep locomotives off the roads in the interests of horse breeders would be a glaring instance of the protection of one class at the expense of the whole community. He was a great lover of horses, but he had a difficulty in getting English horses, and he was also informed that it was almost impossible to obtain English oats, so that he did not see how the farmer would be injured. His experience of French machinery was that, though very beautiful, it was complex and delicate; in machinery for this purpose it was essential that it should be absolutely reliable. In a machine he had purchased from a French manufacturer he had had to make over 120 alterations, in order to make it consonant with English ideas of engineering. The motor of his carriage was 3½ h.p., and it would only mount a hill of, say, 1 in 8 or 10 at the rate of three or four miles an hour; therefore, to go at a reasonable speed up-hill or down you would require at least a 6 h.p. engine. Unless you could keep up a speed of about ten miles an hour irrespective of the road, you did not obtain the great advantage of an automotor car.

Mr. HIRAM MAXIM said he was inclined to agree with the Chairman that mechanical engineers had had rather too much to do with this question. Using steam motors, there would be no trouble in running fast or slow, or reversing, the only trouble was the question of water. He did not think the figures in the paper were quite correct as to the amount of water required to keep a gas-engine cool. A high pressure engine required about 25 lbs. of water per horse-power per hour, and it took about 1,000 units of heat to evaporate each pound of water; there was no reason why the water should not pass off as steam instead of circulating, in which case you only required one-seventh as much condensing surface if you used a gas or petroleum-engine as a steam-engine. These atmospheric condensers were not very efficient, though in his experiments he was travelling at very high velocities. He found that at 42 miles an hour, with very thin copper tubes, 1 lb. of copper would condense 20 lbs. of water. Air, practically speaking, had about one-third the specific heat of water; so that it took about three times the weight of air, and as air was 800 times lighter, it took 2,400 volumes of air for one of water to condense the same quantity of steam. Of course, there was plenty of air, but with a road-car you could not travel at anything like 42 miles an hour, and if you were going in the direction of the wind, he feared an air condenser would not be very efficient. With regard to easily volatile liquids, it was true that much less heat was required to vaporise them than water, but when they were vaporised, their volume was much less and their density much greater, so that what was gained in one way was lost in another. With the heavy oils, he feared there would always be a difficulty in igniting the charge. It took a great deal more electricity to ignite a charge of petroleum vapour than it did one of coal-gas. You could safely stir up the lightest kind of gasoline oil with a heated iron rod, which would then light a flame of coal-gas or set pine shavings on fire. When a heavy petroleum was volatilised by heat and blown into the air, it made a dense white vapour or fog, which would not explode when mixed with air. A flame would not run quickly through it; it encountered the oil in little globules, and before the flame could travel through them, it had to convert them into vapour. If you heated the cylinder above the boiling point of the liquid, the vapours were perfectly transparent, and then if there were 5,000 times as much air present as vapour you had an explosion suitable for driving the machine. With regard to boilers if the the tubes were made very hot it was necessary to make them very thick, and if they were very thick they were heavy. If steam boilers were used he was in favour of having them very light, fed and controlled automatically; and there should be no large quantity of water in any one place. If an explosion occurred it should be harmless if not noiseless. That day two Swedish gentlemen had called on him with two machines, a bicycle and a tricycle which were certainly very remarkable; the latter was a cab driven by foot power, which it was proposed to make and let out at about 2s. a day. There was a most ingenious mode of controlling the number of revolutions made by the wheel at every stroke of the foot, so that it could go at a good speed on level ground, (he was taken to Charing Cross and back in it much quicker than he could have gone in a cab) and he was informed that a man of 16 stone had been taken up a hill of 1 in 10 without any trouble. Of course you could not get any more power out of a man than there was in him, but with this apparatus any power there was in a man was utilized in the best manner; there was no dead centre. The two machines were in the room downstairs. When he was 17 years of age he made himself a tricycle in his spare time, which was principally on Sundays; it had the first suspension wheels ever made in America, but he was then very enthusiastic, and nothing less than 60 miles an hour would do for him, so he geared it so high that he found he had not muscle enough to drive it. About ten years later, he made a set of drawings for a machine with a 3-cylinder gas-engine, to work with petroleum vapour and electric ignition, but for want of means it was never carried out. He felt sure that this idea must succeed; he had seen these carriages in France, and he heard from the United States that they were meeting with success there.

Comte de Dion said, in his view, the chief difficulty was not to make a carriage which would run, but to make one which would stand for a long time without getting out of order. Up to the present, they had all been made with indiarubber wheels, which would not go a very long way without the wheels getting out of order. Ordinary wheels were built to carry a carriage simply, not to bear a strain applied to them at the axle; and he believed the right way would be to apply the power more near the periphery. Another thing he did not much like was the chain; it was always in the dust, and liable to injury. These two points needed special consideration. One of the great difficulties in gas-engines was to get the explosion at the right moment. There were two ways of accomplishing this, one having a bit of incandescent wire, kept hot by a flame of gas; but then, if through any slight leakage the compression of the gas in the cylinder was not quite high enough, the explosion failed. Probably the best way was to have an electric spark, produced by an induction coil, with a make and break contact. With this, the rapidity of the vibrating piece could not well exceed 300 or 400 times a second. But, if the motor ran 800 or 900 revolutions, the moment when the ignition must be made was so sudden, that the electric spark might not come at the right time; there might be one or two misses, and thus power was lost. He had been working at this problem, and had taken the vibrator off the coil, and put it on the engine, so that the vibration was produced by the engine itself. Although, in this case, it gave only two or three little sparks, it was sufficient to ignite the mixture, and used but little electric current. He thought steam carriages were the only ones which would give enough power to draw heavy loads on the road, and that petroleum and electric engines would only be used for small carriages for five or six persons. He was now building a traction engine which would take six or seven tons at a rate of eight or nine miles an hour, and he hoped to be able to show one in England as soon as it was lawful to do so.

The Chairman said it would be impossible to conclude the discussion that evening, and therefore it was proposed to adjourn it to that day fortnight. Before adjourning, however, he thought it only right to call attention to the report of the Parliamentary Committee in 1832, which stated as follows:—

"1. That carriages can be propelled by steam on common roads at an average rate of 10 miles per hour.

"2. That at this rate they have conveyed upwards of 14 passengers.

"3. That their weight, including engine, fuel, water, and attendants may be under three tons.

"4. That they can ascend and descend hills of considerable inclination with facility and safety.

"5. That they are perfectly safe for passengers.

"6. That they are not (or need not be if properly constructed) nuisances to the public.

"7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

"8. That, as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.

"9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered."

He thought these reasons were quite as good now as they were in 1832, and this report would form a good precedent in asking for an alteration in the law.

The meeting then adjourned.

Mr. R. Langton Cole writes:—Murdoch's little model, which terrified the parson of his Cornish village, is carefully preserved at South Kensington. I have seen it many times in the old Patent Museum, and later in the Exhibition galleries. It differs from the usual published drawings only in the means of heating, which is by a lump of red-hot iron placed in the furnace, instead of a spirit lamp.

The adjourned meeting will be held on Wednesday evening, December 11, at Eight o'clock.

Miscellaneous.

LIQUORICE CULTURE IN RUSSIA AND AMERICA.

In a report to the Foreign-office from the British Consul at Batoum, dated 25th March last, an interesting account of the liquorice root industry is given. It is stated to be a comparatively new undertaking in Russia, having been introduced into the Caucasus only four or five years ago by one Greek and two English firms. Both the English firms manufacture the extract, which, together with the raw material, is exported abroad. The Greek firm limits its operations exclusively to the export of the raw material. A few native firms are also engaged in the trade, but only on a very limited scale. The export of liquorice root in hydraulic-pressed bales, in 1894, amounted to 13,318 tons, and the export of liquorice paste was 462 tons. Although the foregoing quantity of root was exported in the year named, it really represents the collections and curing of 1892, as owing to the commercial crisis in America, very keen competition on the part of firms in Turkey, and the opening up of new liquorice fields in Syria, the stocks of 1892 remained in the hands of the firms in Russia till 1894. During the season of 1893, owing to the depressed state of the trade, the amount of root collected was only one-sixth of the quantity collected in 1892, which latter, for the reasons before mentioned, still remains on the hands of the manufacturers in the Caucasus.

The liquorice extract or paste industry might be developed to a greater extent than is the case at present, as the roots are of excellent quality, and the quantity available is practically unlimited; the vast tracts of territory in which they grow are, so far as is known, more extensive than in any other country of the world. The locality in which the root is found is inhabited by a numerous and poverty-stricken population, to whom the existence and continuance of the industry is a matter of vital importance; and it is held that the collapse of the trade would deprive it of a livelihood and involve it in utter ruin. At the present time, however, the manufacturers are so severely crippled by the very heavy railway tariff imposed, especially on liquorice extract, although this article is more easily handled than the root, and provides employment for a much larger proportion of the peasantry of those districts, that they (the manufacturers) are deprived of the possibility of successfully competing with Turkey and the new Syrian fields.

For instance, the present tariff for the transport of extract to the port of Batoum from one of the factories, computes to £2 18s. 6d. per ton gross weight, the paste being packed in boxes representing 20 to 25 per cent. of the total weight charged for. The carriage of root computes to £1 1s. 4d. per ton. The manufacturers say that they are quite unable to compete with the firms in Turkey, which carry on their businesses near the Mediterranean seaboard, and only pay on root one-half, and on paste one-third, of the amount of railway freight that is charged in the Caucasus, and, besides this, their sea freights are from 30 to 35 per cent. less than they are from the eastern end of the Black Sea. They likewise contend that the railway authorities have hitherto classified the extract in the category of valuable drugs, or as a first-class article of commerce, and have applied their railway tariff accordingly, whereas, in point of fact, the manufactured product is now an ordinary article of commerce; and as a consequence of the opening up of the industry in the Caucasus, the value of the extract has decreased by 30 to 40 per cent. Firms in Turkey which have practically held a monopoly in this branch of trade are strenuously opposing the Russian industry, with the object of paralysing and, ultimately, completley crushing it out.

Europe is the only market at present open to the Russian manufactured extract, as America, though the largest consumer of liquorice, has imposed a prohibitive duty, equivalent to the value of the article, on imported liquorice extract; whereas the root or raw material enter the country duty free. The Caucasian manufacturers are agreed that unless a considerable reduction in the present railway rate charged for the transport of liquorice extract be shortly accorded, they will be unable to continue the manufacturing industry; and although it confers greater benefits on the working population than the collection and pressing of the root, it will have to die out, as is evidenced by the fact that one of the largest firms only manufactured and exported about 100 tons during the past year, having found that it does not pay to manufacture on the present basis of railway tariffs. This firm, seeing that it can produce the extract to greater advantage in its factories in Turkey, which are scattered along the Meander valley, in Asia Minor, and at Alexandretta, in Syria, has now entirely ceased to manufacture the product in the Caucasus. The same firm has also a large factory in America for the manufacture of liquorice paste, and the roots collected from its Turkish and Syrian fields are shipped across the Atlantic for manipulation in the United States.

In connection with the subject of the exportation of liquorice root to America, it may be added, that even this branch of the trade may be of very limited duration; for it is a fact that the cultivation of the liquorice plant in America has been under consideration in that country, off and on, for many years past; indeed, so far back as 1854, the Department of Agriculture published, in its annual report, an account of liquorice cultivation in America. In 1886 several acres were successfully cultivated near Sacramento, California; it was, however, abandoned, for want of a home market, and for more profitable use of the land occupied by it; but it is stated that there are still some plants growing on the same farm, as well as in several other places in California. In several places in New Jersey, Pennsylvania, Louisiana, and Florida, liquorice has been grown for some time, and is still growing so satisfactorily, that the proprietor believes it to be quite a feasible matter to introduce the industry on a large scale, so that before many years the entire wants of America in liquorice paste could be supplied by the home-grown root.

COTTON IN CENTRAL ASIA.

At the present time the cultivation of cotton is carried on in the Khanates of Khiva and Bokhara, and in the Turkestan provinces of Samarkand, Fergana, Syr Darjinsk, and Amu Darja section. It appears that both there and in the Turkestan territory the cultivation of cotton, as also all grain and grass, is produced on artificially irrigated land, except in the Fergana district—where a certain quantity of wheat benefits by the rainfall—and at the foot of the mountains. In Turkestan the irrigation land used for sowing covers an area of 2,000,000 dessiatines, the dessiatine being equivalent to about 2¾ acres. As the cultivation of cotton in the Turkestan district increases, so all growths of grain decrease, this being the case especially in the Syr Darjan districts, near the town of Tashkend. The usual time for sowing the seeds is the middle of April; in June the plants blossom, and in September the pods begin to ripen; then the harvest begins, and lasts until the growth of the fibre is stopped by frost, which begins at the end of November, so that the harvest lasts nearly three months. The morning frosts, which generally commence at the beginning of October, have great influence on the quality of the fibre and seeds. The fibres which ripen before the frosts set in are considered the best. A great number of the pods on the bushes do not ripen at all, and consequently are useless. The pods of the American cotton, before the final ripening, lose their green colour, split, and then the hard pressed cotton is to be seen covering the seeds. Soon after this the husks dry, and turn from light green to brown, and the points curl over until they meet, in consequence of which the cotton and seeds become quite exposed. The cotton, which is now quite ripe, swells considerably, and is easily gathered into sacks and baskets. As regards the pods of the native cotton, they do not open, but only turn brown and dry, therefore the cotton is gathered together with the husks. The further working of the cotton, until it is sent to the European-Russian markets, consists only of its being separated from the husks and seeds, and pressed. American cotton requires only separating from the seeds, which weigh two-thirds of the weight of the raw cotton taken out of the pods. Native cotton must be separated from the husks, as well as seeds, a greater part of this work being done by hand. The process of cleaning is to first separate the husks from the cotton with the crushing machine, then to clean the cotton from the seeds with gins. In Turkestan and Bokhara there are many mills for cleaning and pressing cotton, not only in the towns, but also in the larger villages, where markets are held for the sale of cotton. In most of the mills hydraulic power is used instead of steam, on account of its cheapness; but it is inconvenient, because the water to bring the undershot wheels and turbines into action is taken from the irrigation canals, which start from the rivers and streams at the foot of the mountains, consequently the supply decreases towards autumn, when the ice and snow cease to melt, and just when the cleaning and pressing begin. From all those places in Central Asia where the Trans-Caspian Railway does not extend, the transport of cotton and all other goods is effected by camels and by two-wheeled carts. The owners of the camels are Kirgese, who camp on the steppes between Tashkend and Orenburg; and only goods to Orenburg, and principally to Samarkand, from the districts of Tashkend, are transported by camels. In the Fergana districts there are no Kirgese, and the goods are carried by carts. One camel can carry from 14 to 15 pouds, fastened on each side of the hump. A cart can accommodate from 35 to 40 pouds. It is estimated that Turkestan in the future will be able to produce 4,000,000 pouds (144,000,000 lbs. avoirdupois) of cotton. In the Khanate of Bokhara the culture of cotton, grain, and grass is carried on on land irrigated by the river Zaravshan, but this river cannot be used for further irrigation. The quantity of water is so great in the Amu Darja river, that a few million dessiatines more of land could be irrigated from it. If canals are made to run through a large area, it is expected that about 3,000,000 pouds of cotton could be produced by the Khanate of Bokhara. In the same way, the cultivation of cotton would develop in the Khanate of Khiva, and in the Trans-Caspian and Trans-Caucasus territories; so that the whole quantity of cotton, which is estimated at 9,000,000 pouds, now used in the manufacturing districts of Moscow and Lodz, may eventually be obtained from Central Asia, Trans-Caucasia, and Trans-Caspia, and thus obviate the necessity of being dependent for the supply from America and Egypt. Russia is endeavouring, in every respect, to become independent of all other countries; and hopes in time to control absolutely the markets of the East; but it is doubtful whether it will ever be able to do more than raise sufficient cotton to supply her own wants, and even this result is still a remote contingency.

Obituary.

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SIR HENRY PONSONBY, G.C.B.—General the Right Hon. Sir Henry Frederick Ponsonby, who died on Friday, 22nd inst., and was buried on Tuesday, 26th inst., at Whippingham, in the Isle of Wight, became a member of the Society of Arts in 1884, and in the following year he was elected a Vice-President, continuing to hold that office until 1888. In 1890 he was elected for a second term and continued in office till 1894. He was a regular attendant at the meetings of the Council, and his loss will be deeply felt by the Society.

Sir Henry Ponsonby was born at Corfu on the 20th December, 1825, so that he was within a month of attaining the age of 70. After receiving a professional education at the Royal Military College, Sandhurst, he was appointed ensign in the 49th Regiment in 1842. In 1855 he served at the siege of Sebastopol with the Grenadier Guards. In 1870 he was appointed Private Secretary to her Majesty the Queen, and in 1878 keeper of her Majesty's Privy Purse, offices which he held till the period of his severe illness which ended with his death. Full accounts of Sir Henry Ponsonby's distinguished career, and descriptions of the wide-spread regret at his loss as well as the honours done to his memory, have appeared in the newspapers, so that it is not necessary to repeat them here.

General Notes.

PHILADELPHIA COMMERCIAL MUSEUM. — The Philadelphia Economic and Commercial Museum is a municipal institution established by the City of Philadelphia, and consists of collections of natural products from all the countries of the world which have already entered the markets of the United States, or which may be made available for them, together with samples and cases of manufactured products from foreign countries, which may serve as aids to manufacturers. The most important parts of the exhibits from Mexico, Central and South America, Australia, South Africa, and many Asiatic countries at the World's Columbian Exposition, were, at its close, removed to Philadelphia. Similar products from all other countries have been secured, and are being rapidly added to the collections. The exhibits are arranged (1) according to countries, (2) according to products, (3) samples of foreign manufacturers. In connection with the museum is a bureau of information. Arrangements have been made with the Department of State at Washington for special reports on these subjects from consular officers in all parts of the world. Also a scientific and experimental department. In this department a careful study of the scientific and economic value of all products collected will be made. As for instance, tan barks will be carefully examined; woods will be studied; gums and resins will be tested. Many new vegetable fibres will be investigated with reference to new applications, and in general new articles will be subject to scientific investigation for the purpose of determining their commercial and practical value.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 4.—"Mural Painting, with the Aid of Metallic Oxides and Soluble Silicates." By MRS. ANNA LEA MERRITT and PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S. W. HOLMAN HUNT will preside.

DECEMBER 11.—ADJOURNED DISCUSSION ON MR. CUNYNGHAME'S paper on "Locomotive Carriages for Common Roads."

DECEMBER 18. — "Machines for Composing Letter-press Printing Surfaces." By JOHN SOUTHWARD.

Papers for meetings after Christmas :—

"Dairy Produce." By GEORGE BARHAM.

"The Making of a Great University for London." By PROF. SILVANUS P. THOMPSON, D.Sc., F.R.S.

"Some Native Irish Industries." By PROF. HADDON.

"Standards of Light." By W. J. DIBDEN, F.C.S.

"Stamboul: Old and New." By RICHARD DAVEY.

"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL.

"Madagascar." By CAPTAIN PASFIELD OLIVER.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"Supply of Sea-water to London." By FRANK W. GRIERSON.

"The Poster, and its Artistic Possibilities." By GLEESON WHITE.

"The Garden in Relation to the House." By F. INIGO THOMAS.

"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

"Punjab Irrigation, Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I.

"The Economic Development of Kashmir." By WALTER R. LAWRENCE, I.C.S., C.I.E.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Musical Pitch." By A. J. HIPKINS.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons at Half-past Four o'clock :—

DECEMBER 17.—"Jamaica." By FRANK CUNDALL, C. WASHINGTON EVES, C.M.G., will preside.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

W. WORBY BEAUMONT, M. Inst. C. E., "Mechanical Road Carriages." Three Lectures.

LECTURE I.—DECEMBER 2.—Introduction—Easy transport: its attractiveness as a problem, and its national importance—Mechanical road carriages—Early inventions and achievements — Steam on common roads—Carriages and coaches—Success of English constructors—Close of early 19th century steam carriage enterprise.

LECTURE II.—DECEMBER 9.—Second period of 19th century invention and enterprise—Development of steam road locomotives and traction engines—Design and construction—General principles: details—Highways and road locomotives Act—Slow development under oppressive restrictions.

LECTURE III.—DECEMBER 16.—Renaissance of public interest in mechanical road carriages—Recent inventions and achievements—Steam, oil, gas, and electrical carriages, vans, and cycles — French, German, and English vehicles—Passenger carriages — Goods carriers — Roads — Legal restrictions — Pending legislation, probable great importance of mechanical carriage manufacturing industry, and advantages to traders.

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.
January 20, 27, February 3, 10.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.
February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.
March 9, 16, 23.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, the 1st and 8th of January, at Seven p.m., by PROF. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements; and Volcanoes."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Worby Beaumont, "Mechanical Road Carriages." (Lecture I.)
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Engineers, United Service Institution, Whitehall, S.W., 7½ p.m. Mr. W. T. Sugg, "Warming and Ventilation."
Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. Hargreaves, "Alkali Manufacture by the Hargreaves Bird System of Electrolysis." 2. Dr. S. Rideal and Mr. S. Rosenblum, "The Analysis of Chrome Iron Ore, Ferrichrome and Chrome Steel."
Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. John Trist, "Australia's Golden Fleece."
British Architects, 9 Conduit-street, W., 8 p.m.
Victoria Institute, 8 Adelphi-terrace, W.C., 4½ p.m. Rev. R. B. Girdlestone, "Scientific Research and the Sacred Record."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edmund Gosse, "Robert Louis Stevenson."

TUESDAY, DEC. 3...Civil Engineers, 25, Great George-street, S.W., 8 p.m.
Pathological, 20, Hanover-square, W., 8½ p.m.
Biblical Archæology, 9, Conduit-street, W., 8 p.m. Mr. Grey Hill, "A Journey East of the Jordan and the Dead Sea, 1895."
Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. G. Stewardson Brady, "A Supplementary Report on the Crustaceans of the Group Myodocopa obtained during the *Challenger* Expedition, with Notes on other new or imperfectly known Species." 2. Mr. F. E. Beddard—(i.) "Some Points in the Anatomy of *Pipa americana*;" (ii.) "The Diaphragm and the Muscular Anatomy of *Xenopus*, with Remarks on its Affinities." 3. Mr. W. Bateson, "The Colour Variations of *Gonioctena variabilis* statistically examined."

WEDNESDAY, DEC. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mrs. Anna Lea Merritt and Prof. Roberts-Austen, "Mural Decoration by the Aid of Metallic Oxides and Soluble Silicates."
Geological, Burlington-house, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC. 5...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. G. C. Druce, "A New Species of *Bromus* in Britain." 2. Mr. W. F. Kirby, "Notes on a New or Rare *Phasmidæ* in the Collection of the British Museum."
Chemical, Burlington-house, W., 8 p.m. 1. Prof. Armstrong, "The Constitution of Terpenes." 2. "New Derivatives from Oxidibromo Camphor." 3. Prof. A. E. Dixon, "The Chemistry of Dibromopropylthiocarbinide, and the Action of Bromine and Iodine on Allylthiourea."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arnold Dolmetsch, "Old Musical Instruments."
Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. William Bear, "Agriculture and the Currency."
Camera Club, Charing-cross-road, W.C., 8½ p.m. Capt. J. Thomson, "Explosives: their Use and Abuse."

FRIDAY, DEC. 6...Geologists' Association, University College, W.C., 8 p.m. Mr. W. H. Hudleston, "Notes on Indian Geology, including a Visit to Kashmir."
Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. J. Julian, "Considerations with respect to Water, Gas, and Electric Mains, &c., in connection with the Formation of Urban Roads and Footways."
Philological, University College, W.C., 8 p.m.
Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

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FRIDAY, DECEMBER 6, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 1 and 8, 1896, by Prof. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements, and Volcanoes."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue.

CANTOR LECTURES.

On Monday evening, 2nd inst., Mr. W. WORBY BEAUMONT delivered the first lecture of his course on "Mechanical Road Carriages."

The lectures will be printed in the *Journal* during the Christmas recess.

APPLIED ART SECTION.

A meeting of the Committee of the Applied Art Section was held on Friday, 29th November, at 4 p.m. Present: Sir Henry Doulton, in the chair; T. Armstrong, Professor A. H. Church, F.R.S., Lewis F. Day, J. Hunter Donaldson, General Sir John Donnelly, K.C.B., W. Gowland, Sir Charles M. Kennedy, K.C.M.G., C.B., George J. S. Lock, J. Hungerford Pollen, Vincent J. Robinson, C.I.E., Hugh Stannus, Thomas Wardle, with Sir Henry Trueman Wood, Secretary of the Society, and Henry B. Wheatley, Secretary of the Section.

FOREIGN AND COLONIAL SECTION.

A meeting of the Committee of the Foreign and Colonial Section was held on Tuesday, 3rd inst., at 4 p.m. Present: Sir Charles M. Kennedy, K.C.M.G., C.B., in the chair; Major-General Sir Henry Green, K.C.S.I., C.B., Sir Westby B. Perceval, K.C.M.G., Sir Saul Samuel, K.C.M.G., C.B., P. L. Simmonds, with Sir Henry Trueman Wood, Secretary of the Society, and Edward Cunliffe Owen, C.M.G., Secretary of the Section.

Proceedings of the Society.

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THIRD ORDINARY MEETING.

Wednesday, December 4, 1895; W. HOLMAN HUNT in the chair.

The following candidates were proposed for election as members of the Society:—

Martin, Stephen Luther, 20, Thurloe-place, S.W.
Ogilvy, Colonel William Lewis Kinloch, C.B., Itchen Abbas, Alresford.
Pritchard, Prof. William, M.R.C.V.S., 5, Regent's-park-road, Gloucester-gate, N.W.
Stones, James Herbert, 10, Richmond-terrace, Blackburn.
Tavaria, H. K., B.Sc., Victoria Technical Institute, Parei, Bombay.

The following candidates were balloted for, and duly elected members of the Society:—

Adair, R. Shafto, 9, Lower Berkeley-street, Portman-square, W.
Barham, G. Titus, College-farm, Finchley, N.
Benest, Edward Benest Shaw, Caixa 403, Rio de Janeiro.
Bessemer, Alfred George, jun., 27, Killieser-avenue, Streatham-hill, S.W.
Blackburn, Thomas, Barmouth, North Wales.
Bloxam, William Tucker, 1, Lincoln's-inn-fields, W.C.
Briggs, Fielden, D.Sc., Tower-house, Whiteladies-road, Clifton, Bristol.
Browne, Frank, Government Civil Hospital, Hong Kong.
Browning, George Elliot, Blairgowerie, Coonoor, Southern India.
Burgoyne, John William Henry, The Bund, Shanghai, China.

Carulla, Señor Don Federico M., Apartado, 689, Buenos Ayres, South America.
Chandler, John E., Frenches-park, Crawley-down, Sussex.
Chapman, Ernest B. H., 23, Portway, Frome.
Charrington, Mowbray Vernon, The Warren, Hever, Edenbridge.
Cohn, Martin, 122, Elgin-crescent, Notting-hill, W.
Cornish, Miss Jane Square, 9, Maida-hill West, W.
Cragg, Anthony Richard, Maristow-cottage, Roborough, South Devon.
Cross, Right Hon. Viscount, G.C.B., G.C.S.I., 12, Warwick-square, S.W., and Eccle Riggs, Broughton-in-Furness, Lancashire.
Crowther, Charles, Greenmount, Central-street, Dewsbury.
Cuninghame, Richard John, Lainshaw, Stewarton, N.B.
Currie, Alexander John, M.D., 219, Onslow-drive, Dennistoun, Glasgow.
Davis, J. Kennard, Afon-house, Mortlake, S.W.
Davison, Henry, 2, Royal Exchange-buildings, E.C.
Dixon, Arthur William, 122, Abbey-road, St. John's-wood, N.W.
Edwards, George Frederick, Alger-house, 6, Highbury-crescent, Highbury, N.
Evans, George, 1, Wood-street, E.C.
Fowles, Joseph H., 13 and 15, Hornby-street, Heywood, Lancashire.
Gaskell, Francis, M.A., 14, Park-crescent, W.
Gleichen, Captain Count, St. James's-palace, S.W.
Green, Bernard, 42, Warbeck-road, Shepherd's-bush, W., and Ranelagh-road, Westbourne-square, Paddington, W.
Haig, Captain Douglas, 45, Albert-gate, S.W.
Hardman, Samuel, 225, Lord-street, Southport.
Harris, Colonel Josiah, Crofton-lodge, Sydenham, S.E.
Harrison, A. G., 95, Beechdale-road, Brixton-hill, S.W.
Holmes, James, 35, Murray-street, Burnley.
Howmann, S. A. W., 24, Ashbourne-road, Derby.
Jackson, Alfred, 1, St. James's-street, S.W.
Kellner, William, Ph.D., 13, Victoria-road, Old Charlton, Kent.
Kerr, Joseph Malcolm, Falls-mills, Gokak, Belgaum District, India.
Lipscombe, Frederick R., 233, Strand, W.C.
Lloyd, Sampson Zachary, J.P., Areley-hall, near Stourport.
Mabson, Richard R., The Ferns, Upper Hornsey-rise, N.
McGraw, Hugh, 1, Hornsey-lane, N.
Mangles, Henry Albert, Littleworth-cross, Seale, Surrey.
Marshall, Robert Andrew, Hazeldene, 67, Chelsham-road, Clapham, S.W.
Miers, Henry Alex., M.A., British Museum (Natural History), Cromwell-road, S.W.
Mills, George, Westholm, West Enfield, Middlesex.
Milton, Viscount, M.P., Wentworth Woodhouse, Rotherham.
Nugent, James, Chesterfield, Belfast, and 22, Corporation-street, Belfast.
Orr, Robert G., 73, Fitzjohn's-avenue, Hampstead, N.W.
Ottley, Lieut.-Colonel John Walter, R.E., C.I.E., Oakover, Simla, India.
Pearson, George, Brickendon Bury, Hertford, and 10, Victoria-street, S.W.
Priestley, Lawrence, Newark-on-Trent.
Pybus, Richard, Markeaton-mills, Derby.
Rainbow, Edwin, Park-view, The Butts, Coventry.
Ravenshaw, Thomas Edward, J.P., South-hill, Worth, Sussex.
Rigg, Rev. James Harrison, D.D., 79, Brixton-hill, S.W., and Westminster Training College, S.W.
Robinson, Stephen, J.P., Lynhales, Kington, Herefordshire.
Rowell, James, Boston, Lincolnshire.
Searle, James, New River-office, Clerkenwell, E.C.
Stanford, John Benett, J.P., Pyt-house, Tisbury, Wilts.
Stock, Henry Wm., B.A., 9, Denman-street, London-bridge, S.E.
Stott, James, Ravenscraig, Conway, North Wales, and Vernon Works, Oldham.
Tawney, Charles Henry, C.I.E., M.A., Hanover-house, Tonbridge.
Teare, William Frederick, Ballacooil-manor, Patrick, Isle of Man.
Toplis, Frederick, 129, Fellows-road, South Hampstead, N.W.
Turner, A. W., 8, Chowringhee-lane, Calcutta, India.
Tyler, Sir John William, C.I.E., M.D., Lucknow, Oudh, India.
Wade, Edward Hyde R. W., The Cliff, Ry Compound, Colombo, Ceylon.
Weston, Rev. Walter, Carlton-house, Wellington, Salop.
Wild, Ernest Edward, B.A., LL.B., 25, Great Russell-mansion, Great Russell-street, W.C.
Williams, Arnold, C.M., 4, Cumberland-gate, Kew, Surrey.
Willis, Edward, 21, Cornwall-gardens, Willesden-green, N.W.
Wills, William Arthur, 123, Bishopsgate-street, E.C.
Worthington, Herbert, J.P , Glyn-y-mel, Fishguard, South Wales.
Young, Frank Russell, 22, Palmerston-road, Walthamstow.

The CHAIRMAN, in opening the proceedings, said that there had been a good deal of discussion as to the origin of the process which was about to be described. In the attempt to decorate the Houses of Parliament, fifty years ago, simple fresco was used, and it had been generally decided that this was a failure, mainly because of the character of the atmosphere of London, but partly on account of the ground used, which it was said included sea sand, containing a certain amount of salt. Various attempts had been made to introduce some new system, one by Daniel Maclise in his two admirable pictures at the Houses of Parliament, of the "Meeting of Blucher and Wellington after Waterloo," and the "Death of Nelson." Both these works deserved attention, because, although some changes had occurred in consequence of chemical action on certain colours, on the whole they had stood very well. Then Adolph Keim, of Munich, made a great many experiments, and at last invented a method of painting on walls which was a development of the silicate process used by Maclise, but in which all his mistakes were avoided. From the time of Maclise this process had always been regarded as totally distinct from fresco, inasmuch as the picture was not painted on a wet ground, but on a dry wall only slightly moistened. This process was brought to modern public notice by the Rev. Mr. Rivington, and attracted some attention amongst artists, whom he invited to experiment with it on a small scale. Amongst others, he (the Chairman) was asked to try it for a single head, and was so satisfied with the result that he determined to try it again on a more important work if the opportunity offered, as he hoped it would. Mrs. Lea Merritt having tried it more than any other English artist, wrote to *The Times*, calling attention to the promise there was in it; and probably her testimony would have been accepted, but "An Art Critic" wrote from the Burlington Club, declaring that fresco had universally failed in this country, and expressing his conviction that this process would fail, like all the rest. Mr. Harrison Townsend and Prof. Roberts-Austen then wrote, pointing out that this process was totally distinct from fresco, and saying that the pictures resisted damp, as had been well shown in one remarkable instance. The art critic rejoined with a somewhat sarcastic letter, in which he repeated his denunciation of fresco, and warned the public against a conspiracy on the part of Prof. Roberts-Austen and Mr. Townsend to push Mrs. Merritt's pictures. Prof. Roberts-Austen then wrote, pointing out that Mrs. Merritt's first letter had perfectly explained the difference between this method and fresco, and intimated that he hoped shortly to read a paper before the Society of Arts, in which he would give full particulars. That was the paper now about to be read, and he was sure it would prove very interesting.

The paper read was—

MURAL PAINTING BY THE AID OF SOLUBLE SILICATES AND METALLIC OXIDES, WITH EXAMPLES CHIEFLY FROM ST. MARTIN'S, WONERSH.

By. Mrs. Lea Merritt and Professor Roberts-Austen, C.B.

The use of soluble silicates was certainly known to the metallurgist, George Agricola, in the 16th century, and in the 17th. Glauber,* the chemist, described the method of preparing what he called the "Tincture of Pebles or Flints," and, moreover, actually used soluble silicate as a "vehicle" by staining it ruby with gold. He justly observes, "that many great secrets are hid in the contemptible peble or sand; which an ignorant and unexpert man (if they were disclosed to him) would hardly believe; for this present world is by the divels craft so far possessed with avarice that they seek for nothing but money, while honest and ingenious sciences are not regarded at all," . . . . and, he adds, "if an honest godly chymist by the grace of God in his labours do hit upon the right steps and yet do doubt whether he be in the right way or no, then by reading of good and true philosophers' books he may at last learn out of them the firm and constant truth."

We need hardly say that we took Glauber's advice; the literature of our subject is voluminous, and we consulted all the "good and true philosophers' books" relating to it which we could obtain, but we regret that their conflicting advice sometimes left us in doubt as to whether we were taking the right steps, and we were thrown, in no small measure, upon our own experimental resources. The results are described in this joint paper, but the chemist would for the moment beg leave to say that it is the artist who has done all the work, as the chemist has merely watched the case in the interests of science, and in the hope of being able to promote the advance of decorative art in relation to the Church.

We would add that the late Bishop of the Diocese from time to time expressed the most kindly solicitude in the work at St. Martin's, and his appreciation of the results, and we deplore the fact that Dr. Thorold did not live to see the completion of the decoration of the little building in which he took so much interest.

We have naturally turned to the Society of Arts, which has always shown generous interest in efforts to improve the decoration of our buildings, and we therefore ask its members to give their sympathetic attention to the efforts we have recently made to revive in this country a method of mural painting which has, we think, been unduly neglected.

It is not necessary that we should attempt to give the history of mural painting, our object being to describe the method adopted by one of us in the decoration of a little church in Surrey, and to give our reasons for the hope that the results will prove as enduring as they are effective. It is, however, necessary to indicate briefly the nature of the more important methods of mural decoration which have from time to time been adopted.

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* The works of John Rudolph Glauber, translated by Christopher Packe, 1689, pp. 45-47.

An examination of the walls of old churches in this country shows that coloured ornament was widely used in internal decoration. Cases in which true fresco was employed must have been but few, though other methods were frequently adopted. It is recorded,* for instance, that, in the reign of King Henry III., both English and foreign painters decorated the walls of the Royal Palace of Westminster. The foreign artists, Peter of Spain and William of Florence, received sixpence a day for their work, while William the monk, in the adjoining Benedictine Abbey of Westminster, had the higher remuneration of two shillings a day. Their work, however, was probably painted on the walls with colours mixed with oil, oil-varnish being also used. With decorations of this kind we have nothing to do in the present paper. We only offer an incidental reference to the truly-venerable decorative methods of ancient Egypt by which walls were coloured by metallic oxides, as leading to the consideration of the methods in which the surface of the wall is imbued with colour, which, in fact, becomes a part of the mural surfaces. These methods are as follows :—

1st. The method of painting on freshly floated mortar with raw pigments, either mixed with pure water or slaked lime, the ground being both wet and caustic. The painting progresses like the fragmentary fitting of a child's puzzle, the edges left by one day's work being covered by the next. This process is called *Buon' Fresco.*

2nd. The method known as *Fresco-secco,* in which colours are used on a fresh but dry *intonaco,* or ground, but in *Buon' fresco* and in *Fresco-secco* the vehicle is lime water, and the binding is effected by the formation of carbonate of lime.

3rd. The method of painting with a medium of which wax forms a considerable part. The wax mixed with colour, may either be distributed by means of a heated spatula over the design drawn upon the walls, or a brush dipped in colour may be employed. As we shall not have to refer to this wax method again we may add, as showing that the chemistry of the method received some attention, that the artist is directed not to employ an iron spatula, and Van Dyck is said to have used one of horn. The modifications of the wax method are numerous, and some of them involve the use of gums, varnishes, and turpentine, the vehicle being solutions of resin, wax, and paraffin.

It is unnecessary to say that the President of the Royal Academy advocates the use of a particular modification of the wax method, known as "spirit fresco," and that Sir Frederic Leighton used it with admirable effect in his well-known pictures at Lyndhurst* and those in the Gallery of the South Kensington Museum. With regard to this process Sir F. Leighton observed in 1864 that "the only point in which it is inferior to real fresco is in the absence of that pure crystalline quality of light so peculiar to the latter." The South Kensington pictures are, we venture to think, deficient in this luminous quality, and in this respect the new pictures at St. Martin's, Wonersh, leave little to be desired. Mr. F. Madox Brown has also used this Gambier Parry, "spirit fresco" process in his seven beautiful mural paintings in the Manchester Town Hall, and, as he says, has "had no reason to complain of their behaviour." The process is, however, so far as we know, absolutely unsuitable for external decoration.

The Society of Arts viewed this wax process with favour more than a hundred years ago, as it awarded, in 1786, a gold palette to Miss E. J. Greenland,† for her attempts to revive the use of wax in mural decoration, while in 1792 she was thanked‡ for a further communication "on a method of making a composition for painting in imitation of the ancient Grecian manner."

As regards the methods of *Buon' fresco,* so widely practised in early Italian art, from the year 1390, when Pietro d'Orvieto used it at Pisa, we would only observe that it was hardly ever employed alone, as the works were finished with external touches of unprotected *tempera,* which, of course, rapidly faded under atmospheric influences. We owe to Vasari and to Cennino Cennini (1437) clear statements as to the methods followed by the Byzantine artists, and subsequently by the Italians. Cennini says that their works were always finished in distemper. Angelino used solid distemper of excellent quality, which proved to be very enduring. Ghirlandajo employed distemper widely, Perugino painted in pure fresco, and retouched with distemper. We have dwelt on these facts because the retouching with tempera, which is certain to fade, was to some extent rendered necessary by the puzzle-like nature of the work in true fresco, as even the most skilful artist must have left some joins in the frescos which needed covering with colour. In the use of the method, the merits of which we are about to urge, no retouching is necessary.

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* "Vetusta Monumenta."

* *Journal of the Society of Arts,* vol. xii. 1854. p. 203.

† Transactions, vol. v., p. 107.

‡ Ibid, vol. x., p. 168.

It may be useful if we add that M. Marzocchi di Bellucci has, after laborious investigation, recovered many of the old receipts and prescriptions adopted by the early fresco painters, and has recently received a gold medal for his fresco work from the *Société d'Encouragement* of Paris.*

THE SOLUBLE SILICATE PROCESS.

The history of this process, as far as this country is concerned, may be said to have begun with the efforts to revive the use of true fresco in the decoration of the Houses of Parliament at Westminster. Its use in that building is well described in the Reports and letters written by Daniel Maclise, R.A.,† between the years 1859 and 1861, and the *Journal* of this Society shows how anxiously the subject was considered within these walls. We believe, however, that in the interval between the work of Maclise and that done by one of us at St. Martin's, Wonersh—that is, more than thirty years—no decorative work has been executed by the water-glass process in this country, and this fact constitutes the main justification of our paper. The process is referred to at some length in a paper on fresco-painting communicated to the Society in 1864‡ by Mr. Beavington Atkinson, the chair being taken on that occasion by Lord Elcho (now the Earl of Wemyss) who observed that "while they admitted that *fresco puro* was imperfect in itself, let them not on that account give up mural decoration altogether—till they were assured that no good substitute had been discovered." It was on this memorable evening, the 10th of February, 1864, during the discussion of Mr. Beavington Atkinson's paper, that the merits of the process we have adopted and the difficulties which attended the efforts to work in true fresco at the Palace of Westminster, were brought into strong light. Lord Elcho referred to "a most interesting conversation" he had had with Mr. Herbert on this subject," and the following is the graphic record of this conversation as given in the pages of our *Journal*. Mr. Herbert told Lord Elcho that "he had nearly been driven mad by the trouble and annoyance which the old system of fresco caused him. He added that he never knew how the work would turn out, the colours being put on while the plaster was wet, in which state it remained for about eight hours, and having finished a piece one day, he had to wait till the next to see whether it was correct." The results also differed from day to day. "Thus, with respect to the small fresco of King Lear and Cordelia, Mr. Herbert had cut out the head of Lear six times and that of Cordelia five times, and there was no part of that picture which had not been cut out four times," so that evidently much depended on the plasterer. We would here observe that we are satisfied from our own experience that this must have been the case, and we may add that at St. Martin's we maintained throughout the work the most cordial relations with the artificer whom we entrusted with the manual portion of the work. We should not have considered it necessary to say this had not the page of the *Journal* of the Society from which we are quoting recorded the "melancholy fact that Mr. Dyce's and Mr. Herbert's plasterers had each died mad—one raving mad and the other melancholy mad," Mr. Herbert attributing this regrettable incident in a great measure "to the constant worry" to which these unfortunate men were subjected in their department of the process.

In view of these statements, it is not remarkable that the soluble silicate, or water-glass process, the rival of true fresco, found strong advocates, for, as Lord Elcho said, "they had high testimonials in its favour, as it appeared to have stood the test of a good many years. The examples, for instance, of this process at Munich had stood while the (true) frescoes had failed." Reference will subsequently be made to the present state of the pictures by Maclise at the Palace of Westminster.

After a lapse of twenty years the water-glass process, or stereochromy, was again brought to the notice of this Society on the 15th of February, 1884, when the Rev. J. A. Rivington read a paper on the modification of the process, which bears the name of Herr Adolph Keim.

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* *Bull. de la Soc. d'Enc.*, vol. x., 1895, p. 821.

† See the excellent work on mural decoration by Mr. W. Cave-Thomas, London, Windsor and Newton, and also the Twelfth Report of the Commissioners on the Fine Arts.

‡ *Journal of the Society of Arts*, vol. xii., 1864, p. 194 and p. 225.

* *Loc. cit.*, p. 202.

It is to Mr. Rivington's efforts to introduce the process into this country, and to his personal kindness, that one of us was, in the first instance, indebted for information respecting it, and for our knowledge of its details, which we will now proceed to describe. We should, however, state that although, so far as we can ascertain, no decorative work had been executed in this country for thirty years, that is until we worked at St. Martin's, nevertheless, many experiments in the process have from time to time been made by Prof. Church, F.R.S., the distinguished Professor of Chemistry at the Royal Academy. His first investigations on this subject were made in the years 1853-4, and were noticed by the Rev. John Barlow in a Friday evening discourse at the Royal Institution. Prof. Church's latest contributions to stereochromy are embodied in his treatise on "The Chemistry of Paints and Paintings,"* and in a Parliamentary paper to which we shall again refer.

The process of mural painting known as stereochromy was invented about the year 1825 by von Fuchs, and first practised in Germany by a group of artists, of whom Kaulbach is the best known, and in this country by Daniel Maclise, R.A. That the early paintings were less permanent than the inventor hoped they would be, is largely owing to the imperfections in the preparation of the walls and to the too hasty application of the final fixing fluids. These points have been so completely demonstrated that it is safe to conclude that, where the preparation of the wall is thoroughly and conscientiously carried out, pictures can now be painted on the walls of our buildings which will not only resist atmospheric conditions of a trying kind, but may be cleansed by free use of pure water, that is filtered rain water or distilled water.

MANIPULATION INVOLVED IN THE PROCESS.

There is nothing about the process which is beyond the skill of any good plasterer, but it is necessary to follow faithfully the directions issued by the Munich manufacturer of Keim's materials.

The method of painting is simple and the artist may pursue it at leisure, and may retouch the work where desirable until the whole effect is satisfactory. The final fixing of the colours also indurates the wall and vitrifies the painting, so as to make it hard and capable of resisting wet and atmospheric conditions which are ruinous to fresco and tempera. The surface is without lustre, it may be either rough or smooth as the artist wishes, and the colours are both clear and bright. A very full palette is available which comprises forty-five pigments chiefly composed of the mineral oxides with which artists are familiar. Vermilion, cadmium, chrome yellows and madders are not used, but are replaced by red lead, chrome red, and uranium yellows. Zinc white and baryta white replace white lead. The important stages of the process are the preparation of the wall and the final fixing of the pictures, which also completes the hardening of the mortar. In preparing a wall for painting the first care should be to make it absolutely dry. Damp-bricks or over burnt bricks or decaying wood must be cut out and replaced with sound material. Upon the stone or brick wall the first coating of mortar, commonly called rough-cast, must be laid.

For this mortar, lime must be selected which has been slaked a very long time, and the purest that can be obtained. It should have lain some years in a pit thoroughly slaked. In the preparation of the mortar and throughout the entire work, only distilled water or filtered rain-water can be used.

The mortar for the rough-cast consists of four parts of washed and dried sand, to which one-eighth part of Keim's rough-cast extract is added, and one part only of lime. The lime must first be well stirred in twice its bulk of water and passed through a fine seive; then mixed with the sand. Water may be then added to produce the proper consistency.

The wall is to be carefully dusted and made very wet. When it has sucked in the water, a very thin mortar is "thrown" from the trowel, and before this is quite dried, the mortar is again cast upon it in sufficient bulk to make the surface absolutely even. Great care must be taken that the rough-cast is perfectly even, because if this is not the case, the painting ground subsequently laid upon it cannot be made of equal thickness. This mortar must not be allowed to dry too suddenly, as cracks would be caused. In very dry, hot weather, it should occasionally be sprinked with water. If cracks appear, they must be carefully filled. The time that this mortar takes to dry varies according to climate or weather. Under the most favourable circumstances, it would require nearly a year. When dry, the painting ground is laid upon it.

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* Seeley and Co., 1890, pp. 19, 73, and 244.

The painting ground consists of eight measures of dry-painting ground to one measure of lime. Thin and sift the lime as before, and mix it with the powdered material in distilled water. The rough-cast must be made thoroughly wet with distilled water, and the painting ground is then laid upon it. This should not exceed one-eighth of an inch in thickness. It requires some skill to lay it, as the quantity of lime is so very small. The plasterer must only undertake so much as he can finish rapidly before it sets, for if he rubs it after it is dry, the surface will be rotten. When this layer has dried for several days, a crust of carbonate of lime will be formed upon the surface, and would prevent the water-glass from being absorbed in the body of the mortar. To destroy this calcareous incrustation an acid is used. The acid supplied by the Munich firm is diluted with three measures of distilled water. We find that the acid supplied to us for use is hydrofluosilicic acid. This is brushed upon the walls twice in succession by a slow, regular movement from a large hogs-hair brush. The wall is then allowed to dry for twenty-four hours. After the acid is dry the water may be washed twice with distilled water. The hardening fluid as supplied by the Munich manufacturers is then applied, being first diluted with two measures of distilled water. A varnish brush about three inches wide is used for the purpose, and is lightly and evenly drawn over the surface. Drops must not be allowed to run down, and there must be no re-touching. The wall is allowed to dry for twenty-four hours, and the application then repeated exactly as before.

In the case of ceilings, where it is difficult to lift the fluid with a brush, or on walls where the painting ground has from some cause been of unequal thickness (which makes it difficult for the hardening fluid to penetrate equally and so bind it to the wall), it is best to dilute the hardening fluid with four measures of distilled water and to brush over the surface twice in succession, and after it has dried, to repeat the operation in the same way.

Ceilings may more easily be treated by means of spray, but for the acid solution a glass spraying-can must be used. The appliance supplied for fixing may be used for this purpose, the spray being produced by the aid of ordinary bellows.

The ground thus laid is pure white. When struck or scratched it should ring like stone, if rubbed with the finger no little grains should be detached, and water thrown on it should be quickly and evenly absorbed. If the painting ground satisfies all these tests it is ready for the artist, and may be either immediately painted on or it will remain equally fit to receive colour after an interval of years.

Should the presence of any hollow spots in the painting ground be detected by sounding, these must be cut out with a sharp knife down to the rough-cast and replaced, every detail of the successive treatment of the original ground being repeated. The cause of such spots in which there is no union between the painting ground and the rough-cast may either be due to insufficient wetting of the rough-cast, to careless work in plastering, or to insufficient treatment with the acid and subsequently with the hardening fluid. The rough-cast had not, in fact, been penetrated by these fluids.

The colours are found to "work" very freely. They are supplied finely ground in distilled water and are mixed on a tin palette (an aluminium one would be much lighter), with little wells arranged to hold the moist colour.

The wall must be kept wet while painting, for which purpose the spraying machine used for fixing is available. The pigments of course look darker in the wet state than they look when dry, but as the picture may be easily moistened there is no difficulty in harmonising various parts, and a knowledge of the depth of colour to be expected when the work is dry is soon acquired. The use of thin transparent washes npon the white ground or over other colours adds a great charm to the effect. Body colours may also be used. It is, to a certain extent, possible to wash off unsuccessful portions of the colour; but, as in fresco, the best work is that which is carefully traced from finished studies and painted quickly without alteration. Generally speaking, it may be said that the depth of colour attainable is about equal to pastel, although there is a clear transparent quality about the work which differs greatly from pastel.

When the whole picture is finished and has been allowed one or two days to dry, the fixing should be done as follows, but if the atmosphere is not exceptionally warm and dry have the place warmed by fires. The fixing fluid supplied from Munich is diluted for the first and second applications with two measures of distilled water, and for subsequent applications with three measures of water. It is very advantageous to warm it after dilution, by standing it, in covered vessels, in pails of boiling water, as when hot it sets more quickly, but if warmed in other vessels evaporation would cause loss of some of its ingredients.

It is first applied in the form of spray by means of a small appliance specially devised for the purpose, and connected with bellows. Care must be taken to spray the work evenly, and any drops running down should be instantly dried with clean blotting-paper. After drying for twenty-four hours the fixing fluid is applied again, the degree of dilution being the same, but the spraying appliance may be more closely approached to the work, and a more copious douche given without fear of disturbing the colours. After again drying, the fixing solution is again applied as spray, but diluted with three measures of distilled water.

After this the colours will be found to be so far fixed that for further treatment it is best to use a broad paint brush. For the lighter colours four applications of the fixing solution willl generally be found enough, but some colours, notably the darker tints, may require twice as many. The test of perfect fixing is afforded by rubbing the work with a white cloth, or with white paper. Strong white paper or visiting cards may be dragged across the colour to be tested with as much pressure as the hand will exert. If the card shows the least stain of colour, the portion whence it came should be brushed over with the fluid again. No colour should receive more solution than it requires, for "over fixing" would produce a grey, shiny spot. This part of the process is tedious, as time must be allowed for the drying between each application of fluid. In Munich it is always done by an experienced workman. It is well, after the first fixing, to dwell more upon the darker colours, going over those parts a second time with the spray while they are still moist, provided that no moisture lies on the surface, and is thoroughly absorbed.

A few weeks after the fixing, it is desirable to wash the pictures with a copious spray of distilled water to cleanse them from a slight efflorescence that may have appeared.

Von Fuchs recommended that the underground should be treated with two applications of water-glass, diluted with twice its bulk of water. Upon this the painting ground is laid one-tenth of an inch in thickness, and is composed of ground marble or dolomite, with *not too much* lime. The proportion of lime is not fixed, but in Maclise's journal stated to be as one-third. The subsequent treatment of this ground, first with phosphoric acid diluted with six times its bulk of water, in order to convert the crust of carbonate of lime into phosphate of lime, and afterwards two applications, with interval allowed for drying, of fixing water-glass diluted with equal bulk of water. The painting is then executed in water-colours. The fixing is effected by spraying with water-glass diluted with only half its bulk of water, the operation being repeated with intervals for drying until the result is attained.

Reference to the original treatise by von Fuchs shows that the improvements effected by Herr Keim consist, first, in restoring the original scheme of the inventor in the preparation of the wall; second, in fixing the proportion of the lime used in the painting ground at one-eighth instead of one-third of the bulk of powder; third, in directing that the fixing should be done more gradually by more diluted silicate. The fixing fluid, as provided by his manufacturers, is to be diluted with twice its bulk of water, and, after the second application, with three times its bulk, instead of only one-fourth, as prescribed by von Fuchs.

Von Fuchs found that silica combined more readily with two bases than with one, and, consequently, water-glass became insoluble with increased rapidity, when mixed with earths or mineral oxides, forming double and treble silicates. Water-glass exhibits much greater power of adhering to powdered marble and dolomite than to quartz, although a little lime with quartz improved its cementing powers. With gypsum its effect was not satisfactory.

As has been already stated, one of the authors of this paper was instructed in the details and manipulation of this method by the Rev. J. A. Rivington, who most kindly obtained the necessary materials from Munich, and explained their use. Fortunately, he has now arranged for the supply of the materials in London, and has trained a practical man in the preparation of the wall, and in the operation of fixing. The walls of the little church of St. Martin's, Wonersh, which one of us had the pleasure of decorating, were successfully prepared by a skilful local plasterer, employed by its builders, Messrs. Brown Bros., of Bramley, Surrey; there were, however, slight irregularities, which more experience would have rendered it possible to avoid. The process of fixing was, therefore, unduly prolonged. We were anxious to show that, with the exercise of due care, satisfactory results could be obtained by inexperienced plasterers; but the services of a trained workman, who is perfectly competent to fix pictures, can also be secured by application to the Rev. J. A. Rivington, of Bladon Woodstock.

The cost of the materials, the acid, hardening fluid, and fixing fluid, as sold by the Munich firm, is estimated at about 3s. 4d. per square metre of surface. The cost of the colours is about what artists' pigments of the best quality always are in this country.

THE CHEMISTRY OF THE PROCESS.

First, as regards the ground, the simultaneous presence of quartz and marble dust in this painting ground is found to be useful, and we ascertained that the material we employed gave on analysis the following results:—

Free Silica (quartz sand) ..	52·28
Lime	26·96
Carbonic anhydride	20·72
	99·96

which corresponds to about equal parts of quartz sand and marble dust. This ground is mixed with eight measures of lime and laid on the wall as has been already indicated. The ground when dry is treated in the manner already described, with a dilute solution of hydrofluosilicic acid. Analysis proved that the undiluted solution contained 2·34 per cent. of acid (H_2SiF_6). The object of treatment with this acid is to destroy the superficial layer of carbonate of lime and to form silicofluoride of calcium, which is, however, not insoluble. The use of the solution of hydrofluosilicic acid constitutes, in our opinion, one of the chief improvements of the process, for at the time Maclise worked, dilute phosphoric acid was recommended for the preliminary treatment of the painting ground, the object being to form phosphate of lime. The use of hydrofluosilicic acid gives rise to very complicated reactions, the nature of which we are still investigating. It is probable that some hydrofluosilicic acid may remain on the painting ground until the first treatment with the potassium silicate, and, if this is the case, the effect would be to form fluosilicate of potassium, which is comparatively insoluble and so acts as a cementing agent. It seems clear that gelatinous silica is also precipitated.

Treatment with the solution of soluble silicate then follows, and we find that the undiluted solution contains:—

Silica	22·03
Potash (K_2O)	8·19
Water	68·92
	99·14

Which corresponds roughly to the formula $K_2O,4SiO_2$. We should state that these analyses have been made under the direction of one of us, by Mr. William Groves, in the Royal Mint Laboratory.

Painting with the pigments then ensues. It is stated by Prof. Church that the pigments should be treated, as recommended by Kuhlmann, with some of the fixing fluid and then re-ground; and in some cases they require the addition of oxide of zinc, powdered marble, powdered glass, carbonate of baryta, soluble silica, and hydrate of alumina, "in order that their natural inaptitude for equal fixation by the alkaline silicate should be remedied." When the picture is completed the fixing solution is applied, and we find the application of the fixing solution completes the cementing together of the particles of the ground, and of the various pigments by forming an alkaline carbonate and double silicates. Analysis proved that the undiluted solution we used contained 16·50 per cent. of silica.

The main constituents of these silicates must be calcium and potassium, the other bases will of course vary with the pigment employed, and as these are mainly metallic oxides, either natural or artificial, the silicates formed will, therefore, correspond to certain minerals which are met with in nature. It appears from an examination of some sections that the mere cementing action of the silicate of potash is considerable, apart from any important chemical change, and we are satisfied that sufficient attention has hardly been devoted to the fact that the external coloured layer which contains the pigment is very thin compared with the rest of the section of the ground, and that it is very difficult to determine by chemical analysis alone, what changes have really taken place. It is certain that the glazing action which results from the treatment with the soluble silicate is very considerable, and it must be remembered that the colour of the pigments are not materially changed by their union with the silica. In many cases we have examined it seems as if the silicates which are formed, whatever their composition may ultimately prove to be, is only coloured by the oxides used as pigments, just as the coloured bands of agate often owe their tints to the presence of enclosed metallic oxides.

It will be evident, therefore, that the study of the chemical reactions must be supplemented by petrographical examination. Portions of the finished fresco must be treated as if they were natural rocks by cutting them into sections, for submission to micrographic investigation in the usual way. By the kindness of Professor Judd, C.B., Dean of the Royal College of Science, we have had such sections prepared, and one section coloured, as seen by reflected light, brilliant yellow and red, will be thrown on the screen.

A careful examination of the section reveals the fact that the pigments are unaltered. The quartz grains are apparently not attacked, but the carbonate of lime has been acted upon, and an isotropic substance, probably silica, has infiltrated into the cracks, the cleavage, and the twinning planes of the marble grains. There are little masses of a substance, probably silica, acting as a cement. The surface from which this section was cut had been prepared about three years, and it will be interesting to see whether in the course of time silicates slowly form. There appears to be some of the marble dust remaining in it after the hydrofluosilicic has done its work. It will be evident that if failure in stereochromy should occur, the cause of failure can be more surely traced by micrographic examination than by any other known method.

As regards the work at St. Martin's we would only observe that some of it has now been completed for nearly three years, and that no trace of deterioration is evident. No efflorescent bloom — which is, we think, mainly caused by the use of silicate of soda instead of silicate of potash, for the ground, and to the undue use of the fixing solution—has appeared over the surface of the pictures, nor have the colours, so far as we can detect, faded in the least degree. One of the pictures was by accident subjected to a severe test, as a defect in the roof freely admitted rain water from behind, and one of the heads, a figure subject, was thoroughly drenched with water, a test it stood perfectly.

THE RESULTS OF THE EARLIER EFFORTS IN STEREOCHROMIC PAINTING.

As has been already stated, the method was employed in the decoration of the Royal Palace of Westminster. In a report dated December, 1859,* Daniel Maclise states that he did not consider it necessary to treat the painting ground with the soluble silicate before beginning to paint. He therefore omitted to do so, acting on advice which had been tendered to him by eminent German authorities, but we consider that this omission was most unfortunate. He also seems to doubt whether organic colours, such as lakes and madders, were really unsuitable, and he said that "water-glass does not affect them to any appreciable extent." We have no reason, however, to suppose that he really used organic colours. F. Madox Brown* has recently referred as follows to "the water-glass process in which Daniel Maclise's great paintings have been executed." "I see no precise reason," he adds, "why these noble works should not last and defy climate for many long years yet, though from want of experience he very much endangered their durability through the too lavish application of the medium." We think that as regards the preparation of the ground he was not lavish enough. The actual state of the pictures in the Palace of Westminster is often cited as telling heavily against the use of the process we are advocating. It is fortunate, therefore, that during the present year an authoritative report on their condition has been made by Prof. Church. This interesting Parliamentary document† begins with the reassuring statement that "the two water-glass (or stereochrome) pictures in the Royal Gallery are in a generally sound condition," this is, however, qualified by the observation that they are "obscured by a white efflorescence." Mr. Herbert's "Moses," painted in water-glass, is also "obscured in a few places by a white efflorescence," but flecking the picture with soft linen, followed by treatment with soft bread, "restores the obscured parts to their pristine beauty." With regard to the pictures by Maclise, Prof. Church found that they were covered with a grey film, which, on analysis, proved to contain the sulphates of calcium, potassium, and sodium, with traces of ammonium compounds, but it is in the highest degree satisfactory to learn that "the colours underneath the above-named film, were firmly attached to the plaster." In the case of the "Nelson," finished in 1865, a "deep blue pigment and a deep red pigment were found to be rather loosely attached." We were aware that certain colours required more careful fixing than others, and in the work at St. Martin's special care was devoted to this particular point.

It seems to us that the worst that can be said against the process is that in the smoky atmosphere of a great city, soot and moisture will be deposited on the surface of the pictures, and that this moisture will carry with it "dissolved sulphuric acid from the atmosphere," but the pictures will wash, and can readily be washed, though in a country atmosphere they will not probably rarely need it. It is unnecessary to point out that distilled water must be employed for these ablutions.

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* 12th Report of the Commissioners on the Fine Arts.

* "Arts and Crafts" Essays, Rivington, Percival & Co., 1893, p. 153.

† Copy of Memoranda by Prof. Church, furnished the First Commissioner of Works, Parliamentary Paper, c. 7,651. 1895.

Brief reference should be made to the use of this process for external work, and we would add that we have been provided with satisfactory testimony as to its permanence from Professor Lindenschmit and others who speak from long experience and in no uncertain words. In this country Mr. F. Shields has painted a lunette over the entrance to the chapel in Hyde-park-place, and he will we trust state his views as to the use of this process, and the day may not be far distant when we may hope to be reminded by decoration on the exterior of our churches of the little Alpine Chapel which Browning describes as follows:—

"It has some pretension, too, this front,
With its bit of fresco half-moon wise
Set over the porch, art's early wont;
'Tis John in the Desert, I surmise,
But has borne the weather's brunt."

As we believe that St. Martin's, Wonersh, is the first church in this country in which this process has been adopted, we may be permitted to briefly indicate the scheme of its decoration. This has already been described by the architect of the church, Mr. C. Harrison Townsend, of 29, Great George-street, in a paper submitted to the Institute of British Architects in February, 1894. He says that,* "Throughout the whole of the design of my little building I bore in mind the intention of decorating its interior in polychrome. As this feature was to be its main feature, the exterior, for instance, was kept entirely plain and simple; and effect was gained by proportion and colour-value of its material, rather than by any elaboration of detail or mouldings. In the interior the problem was to obtain, notwithstanding the unusual lowness of the building, a maximum amount of surface—not being a flat ceiling—upon which to execute a series of all but life-size subjects. This the semicircular form of ceiling enabled me readily to do, the springing line of which is but seven feet from the floor. About half-way towards the highest point of this barrel ceiling a moulding runs the length of the church, and, while it is proposed that the upper portion shall be enriched in plaster surface ornament and solidly gilt, the surface below this moulding to the springing line is left free for the work of the fresco painter. Divided as it is by the "bonnet heads" over the windows, it resolves itself into a series of two large spandril pieces on each side, and of a smaller one against the west and another against the east walls."

[The general design of the church is indicated in the engraving on p. 48; but the walls merely show the general scheme of the decoration, as designed by Mr. Townsend. The pictures, as actually painted by Mrs. Lea Merritt, were represented by lantern slides, which do not admit of reproduction here.]

There can be no question that the revival of mural painting is a matter of much interest and importance, and we will conclude by a brief reference to authorities on decorative art. We would first appeal to the old painter, Cennino da Colle, who in the beginning of his famous "Treatise on Painting" quaintly traces the history of art by reminding us that "Adam began by digging and Eve by spinning." "Then," he adds, "followed many arts; now the most worthy is science; after which comes the art derived from science, and dependent on the operations of the hand, and this is called painting, for which we must be endowed with imagination and skill to discover things (concealed under the shade of nature) . . . . and well does painting deserve to be placed in the next rank to science and to be crowned by poetry." The place of decorative art is, indeed, a very high one, as Mr. G. F. Watts told us when Mr. Rivington's paper on silicate painting was read to this Society in 1884. Mr. Watts wrote as follows:—"The highest expression of painting as a decorative effort belongs to designs composed with reference to architectural combinations, and I cannot but feel that when the habit of producing such works falls into absolute disuse, art must take the lower place of being only a luxury." Later still Mr. William Morris has told us that "the position which we have to face is this; the lack of beauty in modern life (of decoration in the best sense of the word), which in the earlier part of the century was unnoticed, is now recognised by a part of the public as an evil to be remedied if possible . . . . but no general sense of beauty is extant which would force us into taking up the dropped links of tradition, producing genuine organic art."

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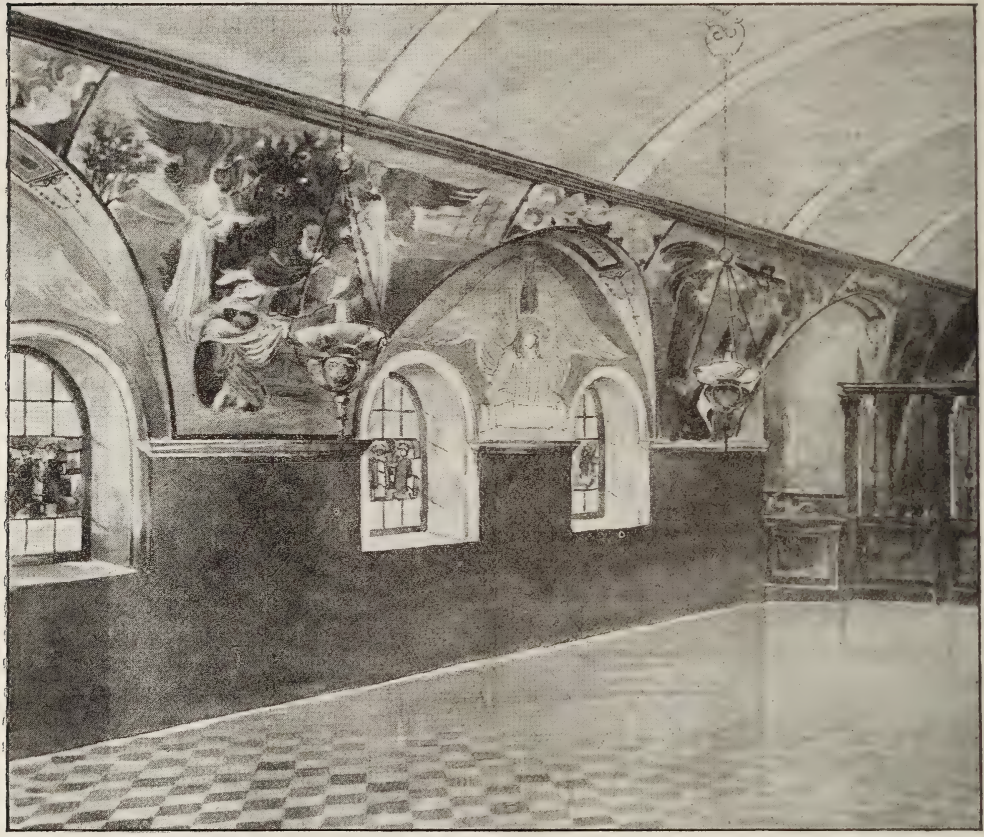
* "Journal of the Roy. Inst. of British Architects," vol. i. 1894, p. 247.

The authors of this paper hope, by the aid of a process which can be trusted, to revive the old traditions of mural decoration, and they believe this paper will show that in making the effort the artist and the chemist must work together.



Besides the lantern slides, the paper was illustrated by a picture by Mrs. Lea Merritt, a portrait by Mr. Holman Hunt, painted in the process, various specimens by the Rev. J. A. Rivington, and chromolithographs of frescoes by the old masters, lent by the Arundel Society.

DISCUSSION.

Mrs. LEA MERRITT said her part in the paper was limited to the technical details, and she thought Professor Roberts-Austen made one little slip in reading it when he said that after treating the wall with acid it should be washed; as she understood the acid was left on until the second coat of silicate was applied.

Prof. ROBERTS-AUSTEN said that was how the statement in the paper originally stood, but he had been informed that evening by Mr. Rivington that Keim recommended washing, as it tended to drive the silicate further in.

Mr. BATTEN asked if the pigments were mixed with water only, or was anything used to make them adhere.

Mr. WALTER REID said he thought it was evident that the pigments were not converted into silicates, but were really enclosed by gelatinous silica, for the simple reason that in many cases the silicates were of a different colour from the oxides; for instance, red oxide of iron, if converted into silicate, would become a dirty green. The real essence of the matter was the foundation to which the pigments were applied, and the failure of most other kinds of mural painting was due to the imperfect preparation of the wall. The film of colour must be so thin that any crack or alteration in the surface would make it flake and peel off. This reminded him of the extreme care used by those artists whose paintings had lasted longer than any others, the Greeks and Romans. The way in which they prepared their walls was described by Vitruvius, as carried out in Pompeii. They took first rough-cast plaster of sand and lime, but the sand was puzzolano, which rendered the lime hydraulic, and probably in London one would try to substitute for it ground brick, or pulverised burned clay, as Vitruvius recommended for use in localities where puzzolano could not be obtained. This point was important because the foundation being a silicate, there would be the same expansion and contraction by variations of temperature or moisture as there was in the film upon it; if there were the slightest difference in the co-efficient of expansion the film must go. A second and a third coat, each being thoroughly dried, were added, and then three coats of marble dust and lime were applied in the same way, so that there were six coats in all. This care, however, was amply repaid. He had himself examined some very beautiful frescoes by Kaulbach, in front of the museum in Berlin, and also the effloresense from the surface, which was mainly carbonate of potash and soda, especially soda. There was a great difference between that and the efflorescence which occurred here, which was chiefly composed of sulphates, arising from the many sulphur acids present in the London atmosphere. An efflorescence of carbonates did not do nearly so much damage as sulphates, and sulphate of soda was specially injurious. In damp weather it sank into the plaster, and in dry weather crystallised out again, so that there was a constant action going on similar to that of the freezing of water, which would disintegrate the best building stone. He had made many experiments on the presence of such sulphates in limes, and suggested that any lime to be used for such artistic purposes should be burned, not with coal, but with some fuel which did not contain sulphur, such as petroleum or wood. Sulphur would then be eliminated at any rate from the background, and as it might be hoped the surface would be impervious that would prevent it entering from the front, and there would thus be a good chance of the painting remaining uninjured. He should like to know if any paintings executed in this method had stood the test of exposure for any length of time. The phosphoric acid had been proposed by Kuhlman of Paris, and from a chemical point of view he should think it might have advantages over hydrofluosilicic acid. Phosphate of lime was almost perfectly insoluble, and would protect the other pigments, but fluosilicate of lime was something soluble. Fuchs, in Germany, was the inventor of stereochromy in 1825, and Maclise did not use it in this country until about 1859 or 1860. In conclusion, he did might say that he had found slate, which did not exfoliate when ground, a capital foundation for painting on, and if it were employed and the colours fixed with silicates he believed the work would stand almost anything.

Mr. R. HALLWARD said if he were not out of order he should like to say a word in favour of tempera. He had used it a great deal and, though he could not speak from long experience, so far he had found it permanent. But, going beyond his own experience, there were churches in Norfolk and Suffolk decorated in this manner; and he had recently being looking at the roof of Palgrave Church, which was probably of the 15th century, and though the work was comparatively simple, not pictorial, he believed it retained all the beauty and colour it had originally. He lately came across some words of Ruskin, the purport of which was that, as the result of many exhaustive inquiries, he came to the conclusion that all the finest work on the walls of the churches in Italy during the best period was executed primarily in tempera. He had not studied the Italian work sufficiently himself to give an opinion, and whether Mr. Ruskin had at all confused the original work with retouching afterwards, he could not say, but he did not think he had. If this were so, the enormous advantage of tempera was obvious; it imposed no conditions whatever; the artist could work with the greatest freedom, and express himself with as much facility as in oil-painting. You could absolutely do what you liked with it; it should be as much in the surface of the wall as on it. It was a thin medium when properly used and sank into the walls, and that, he believed, was one reason for its permanence.

Mr. H. JACKSON suggested that if this process insured that there should be no change at all in paintings after their execution, it would not permit of that mellowing by the hand of time which was generally considered to add beauty to works of art.

Sir HENRY DOULTON said he was not prepared to say anything about the process itself, but he had seen the examples in Wonersh Church, and thought them very beautiful.

Mr. WESTON asked the strength of the acid used.

The Rev. J. A. RIVINGTON said he was very glad the point had been insisted on that this process was not fresco. As long as the public or those interested in art were under the delusion that they were trying to revive fresco painting by this means, nothing would come of it. He was also much obliged to Professor Roberts-Austen for the rock sections he had shown, which had carried the science of the subject into an entirely new sphere. Since he first brought forward the matter, nearly twelve years ago, he had seen reason to modify a great deal of the chemistry he then put forward, but during this period his faith in the process had increased. He had paid frequent visits to Munich, and had seen great works of art on the exteriors of buildings which had withstood the atmosphere of a large town and of a climate much more severe than that of England. Only recently, he saw pictures which he assisted in fixing twelve years ago, which retained their colours perfectly; some blocks of houses, almost giving the impression of entire streets, were painted from top to bottom in this process, and nowhere was there any sign of failure which could be attributed to any defect in the process itself. There had been mishaps now and then, but they had always been traced to neglected work. He regretted that Mr. Shields, who had trodden in Mrs. Lea Merritt's footsteps, and was as enthusiastic as herself, was unable to be present. He had completed two lunettes to go over the doors in Hyde-park Chapel, which would be visible as soon as they were fixed, which he should be doing on the following day. The interior of the chapel was about to be done entirely in this process, so that by next summer there would be an opportunity for everyone to see what it was capable of. Water was the only medium employed—it was a pure water-colour process; filtered rain-water would do in the country, in London it must be distilled. He pointed out in his former paper that it was Roman and Greek work which Keim had taken for his models, and he had, somewhere, samples of Pompeian frescoes showing the coarser ground underneath and the finer on the top, but could not put his hand on them that evening. There were, however, only two grounds; six were not required. Mr. Keim eliminated all soda from his fixing and hardening solutions in order to avoid the evils Mr. Reid had mentioned. There were paintings abroad which had stood for fifteen years exposed to very bad weather; one in particular he had in mind, on the outside of a church which stood above the other buildings in the town. The winter there was very severe, and after a heavy rain sometimes a sharp frost would come and the whole painting had been at times covered with a thin coating of ice; but when the thaw came it proved every time that the painting had stood perfectly. As yet there was not the slightest indication of a flaw either in the painting or the ground underneath it. He had no doubt that ground slate would form a durable surface, but feared the expense would be prohibitive. Mr. Keim at first used pumice stone, but gave it up afterwards, and as far as one could judge quartz and sand answered every purpose. There was something else developing now, but he was not yet able to give any details with regard to it. One gentleman remarked that the simpler a process was the better, but although this process sounded complicated, the artist had nothing to do with the complication. Nothing could be more direct or simple than the artist's part of the work. He had simply to mix his paint with water and put it on. All the trouble was for the workman who prepared the surface, and he believed from a workman's point of view it was as simple as possible. The trouble and complication was for the chemist who tested it. Whether one could ensure that there should be no change was entirely a chemical question, but though he was not an artist, he devoutely hoped the chemistry of this process would effectually protect it from the mellowing hand of time. If he were painting a picture he should be very sorry to think that any mellowing hand was required to improve his work. This idea reminded him of a time when the object of English art was to produce a so-called "black master," but he hoped that time had gone for ever.

Prof. ROBERTS-AUSTEN, in his reply, first drew attention to two palettes on the table, one of which had been exposed for some months to the atmosphere of his laboratory; but he really could not tell, from observation, which it was. He also had specimens of painting on cloth and canvas, lent him by Mr. Rivington, which had been saturated with spirits of wine, and then fired, to show how durable was the work. A little picture, by Mr. Rivington, showed that he was over modest in disclaiming the title of an artist. In answer to Mr. Reid, he might say that he had deliberately rejected phosphoric acid, for though phosphate of lime was not insoluble, phosphate of potash was nearly so. With regard to tempera, he should think a careful inspection of the Florentine churches would convince anyone that they had suffered very much from time; and probably Mr. Ruskin had re-touching in view when he used the words referred to. They all reverenced Mr. Ruskin, but probably, if anyone showed him tempera work in an advanced state of decomposition, he would say that did not affect anything he had said with regard to tempera generally. The strength of the acid was stated in the paper; he believed it was about 2 4 per cent. With regard to the question whether these paintings would undergo change from the atmosphere, he feared that in London there would be some degree of "mellowing," quite apart from any chemical change, which he hoped would not occur, but that frequent ablutions and occasional flicking with a silk handkerchief would really preserve the pictures. The experiment was now being made whether the paintings were really permanent; he could only, as a chemist, express his firm belief that they would be.

The CHAIRMAN said he hoped one result of this paper would be to bring about greater enthusiasm for mural decoration, which, in his time, had ceased to be in demand at all. The unfortunate failure of fresco painting gave an excuse to people who had no real interest in art to forswear mural decoration altogether. Artists must take something on trust, but they now had a chemical assurance, backed by some amount of practical experience, that this work would be permanent. No doubt Ruskin expressed a preference for tempera painting over fresco, but he associated fresco with the decline of art. Shakespeare said "Fortune rarely comes with both hands full," and the time when fresco painting was introduced was just the time when that simplicity of invention which Ruskin so much admired was beginning to disappear. Many of his disparaging references to Michael Angelo had a good deal to provoke them; there was something a little bombastic in his style which was very repugnant to Ruskin, and he failed to appreciate what was really great in his work. But in condemning fresco, he was condemning what was accidental, not what was essential to it. He (the Chairman) remembered one example, the Santa Maria Novella, which was very much affected by the weather; in other cases where the paintings had been better protected they had been preserved very well. It was evideut, however, that some more trustworthy process was wanted. No doubt in looking at some old pictures they had a feeling that the "mellowing hand of time" had added beauties to them, as in some instances of the quattro cento and cinque cento period in the National Gallery, where the colours had not only been preserved, but something like a process of vitrification had taken place which gave them almost the appearance of precious minerals, but in the majority of cases a very different kind of change had taken place. No one could persuade him that the brown masses of foliage, rich brown as they were, which came close up to the edges of the flesh, illuminated by a strong light in Titian, were brown originally; they were green, and the green had gone. They admired them now, but they would admire them much more could they see them as they were originally. Mr. Ruskin on one occasion referred to this prejudice in favour of the changes in old pictures, and said a picture was never so perfect as the moment it left the painter's easel. He believed it was the case except where the enamelling process he had spoken of took place. There was a deplorable lack of appreciation of grand art in England. The artist must bow to the caprices of rich people who wanted to decorate their drawing-rooms, where a grand serious picture was felt to be out of place. Such works must be in public buildings and churches, and every excuse for neglecting such opportunities should, if possible, be taken away. For this reason he hailed the present paper, and concluded by proposing a vote of thanks to Professor Roberts-Austen and Mrs. Lea Merritt.

The vote of thanks having been carried unanimously,

Prof. ROBERTS-AUSTEN briefly responded, and the meeting adjourned.

Miscellaneous.

THE FOREST WEALTH OF NEW SOUTH WALES.

Open forests cover the greater portion of the surface of New South Wales, and are found in every formation. Mr. T. A. Coghlan, Government Statistician of the colony, in his work on the wealth and progress of New South Wales, says that the varieties of trees met with are chiefly species of the eucalyptus tribe, aud melaleuca, callistemon, and other genera of the order myrtaceæ. The trees are for the most part straight and cylindrical in the trunk, and when full grown their first branch is at a considerable height from the ground. The roots of the eucalyptus lie at no great distance from the surface soil, an adaptation of nature to the peculiar climatic conditions of the country. The finest specimens of most of the timber trees, those yielding the most valuable timber, are found on ridges and hill sides, in places frequently too rough and strong for cultivation, and this circumstance is in many ways fortunate for the colony. In the course of settlement, when the rich plains are denuded of their trees, and when scarcity will make timber more appreciated than it is at present, land not adapted for agricultural settlement will still be available for the cultivation of the finest trees. On the river flats immense specimens of flooded gum and apple trees mark the course of the streams. The flooded gum grows to a height of one hundred feet, and its wood is most useful for heavy work, and for structures liable to attack by the white ant. The apple tree has more spread than the majority of indigenous trees, and its wood is strong, heavy, and durable. The distribution of the species is very extensive. On the ridges and mountain sides other varieties of trees predominate. The box reaches 180 feet in height, with a thickness of 6 feet, and the timber is used chiefly for firewood, for which purpose it has no superior. The bastard box, supposed to be a cross between the box and the grey gum, is widely distributed over the colony. Iron-bark is a tree of moderate size, usually, when full grown, from 60 to 80 feet in height, though the white iron-bark attains a height of 150 feet. The timber is heavy, and renowned for its great strength, five specimens bearing a tensile strain nearly twice as great as the best oak. The timber is used most extensively for wharves and bridges. The iron-bark and box are slow growing trees as compared with many other varieties, such as the blue gum, the latter attaining a great height in a very few years. The blue gum, one of the finest of the eucalyptus tribe, is only met with in portions of the southern tableland, but a description of the blue gum, called flooded gum, grows extensively in the coastal districts. It attains a good height, and is rather thicker in the trunk than most varieties of gum trees, sometimes reaching 7 feet in diameter. The timber is in great demand owing to its comparative lightness, and is easily worked. The spotted gum grows in all the coast districts and in some portions of the interior, generally where the soil is poor. This is one of the handsomest of the forest trees, and attains a height of 100 to 150 feet. The quality of the wood varies greatly, according to the habitat and character of the soil; when good, it is considered specially adapted for ship building. Stringy-bark, so called from its peculiar fibrous bark, grows chiefly on the northern tablelands. It is a large tree, and its wood is of great and general utility. The bark is extensively used for roofing, and forms a very useful paper-making material. The

"Messmate," also called stringy-bark, is one of the largest of Australian trees, being frequently met with more than 250 feet in height. The bark is used for roofing, being similar in character to that of the tree just described; it also forms an excellent paper-making material. The blood wood is a large tree, growing in the coastal districts of the colony. The timber is used chiefly for fencing purposes, and for railway sleepers. The grey gum grows to a height of 150 feet, and is extensively distributed over the whole of the coastal districts. It yields excellent timber, hardly inferior to iron-bark. There are several varieties of this tree, some of which produce wood of remarkable beauty and of great durability. The tallow wood is a very large tree, growing extensively in the forests north of Sydney. The wood is more easily wrought than most of the hard woods, and has great strength and durability, being employed largely for floor and other building purposes, and for the decking of ships. The mountain ash, or white top, is found both on the tablelands and in the coast districts. Its timber is in demand for coopers' work, and for rough carpentry. The tree grows to about 150 feet in height. The turpentine tree is found mainly in the district lying between the Shoalhaven and the Macleay. It grows to magnificent proportions, sometimes reaching a height of 200 feet, with a diameter of 6 feet. The timber is largely used for piling and other work in sea water, as it resists the attack of the teredo better than any other New South Wales timber. The brush forests cover a considerable extent of country along the coast. The trees found in them differ entirely from those of the open forests, and there is no lack of variety, either in the character of the trees or the colour of their foliage. Tall, graceful fern trees, sometimes attaining a height of 60 feet, beautiful varieties of palms, cabbage trees, and Moreton Bay figs of enormous proportions, are prominent features of the brush, though these are perhaps more ornamental than useful. There are, however, found in the brush forests, timber trees of the greatest value. The red and white cedar were once abundant in the northern forests, but at present few of the full grown trees are met with except on the high ridges. The red cedar is a magnificent timber tree, often attaining a height of 150 feet, with a girth of over 30 feet. Its timber is of great value, being light, easily wrought, durable, splendidly grained, and well adapted for furniture and cabinet-making. The white cedar is a pretty tree, growing to a height of 80 feet, with a diameter of 3 feet. Its timber is soft and easily worked, but is deficient in tensile strength and durability, and, therefore, in no great demand. The silky oak grows to a height of about 80 feet under favourable circumstances, and yields a wood very suitable for cabinet-making. The tulip wood is a tall tree with beautifully-marked timber of various shades, and susceptible of a fine polish. The ash or pigeonberry tree grows to a great height, sometimes reaching 130 feet, with a diameter of 5 feet. Its timber is light and tough, and in good demand. The colonial pine is one of the finest trees of Australia, sometimes reaching a height of 200 feet, with a trunk 4 feet thick. Its timber is extensively used, being cheaper than any imported pine; it is white in colour, and easily wrought. Native beech is also a tree of noble proportions, reaching 150 feet in height. Its timber is in great demand, being superior to most native timbers when exposed, as it neither shrinks nor warps. In colour the wood is white or silvery, with a fine close grain. Besides the varieties named, there are in the brush forests many other trees, yielding timber of large size and great value. In conclusion, it is stated that few countries have such a wealth of timber as New South Wales possesses. Its woods are as varied as they are valuable, ranging from the iron-barks—unsurpassed for work requiring hardness and durability—to the kinds suitable for the most delicate specimens of the cabinetmaker's art. The timber resources of New South Wales are more valuable than those of any of the other colonies, and yet the export trade is exceeded by that of Western Australia and New Zealand.

Notes on Books.

PHOTOGRAMS OF 1895. London: Dawbarn and Ward.

Photograms are merely what ordinary people understand by photographs, and this well got-up book consists of a selection of the best photographic productions of the year reproduced and criticised. The greater number are exhibits at the photographic exhibitions and the Photographic "Salon," but there are also a few which have been shown elsewhere, and some from America, New Zealand, India, and Japan.

The reproductions are good illustrations of the best process work and the criticism is liberal in tone and kindly in spirit. An introduciion is furnished by Mr. Gleeson White, but it does not appear whether the same gentleman is responsible for the bulk of the work or whether it is anonymous. Mr. Gleeson White has something to say about the vexed question of photography and art, and his conclusions may fairly be accepted that the pretensions of those who claim for photography the power of rivalling the best work of the brush or the pencil, are not much more extravagant than the arguments of those who deny to the works of the camera any original power whatever.

The pictures here reproduced show how much scope there is for originality in photography, and prove, what is well known to those who have paid attention to the subject, that the work of different photographers may be as readily discriminated, and their style as easily appreciated, as the work or the style of different painters or etchers. Even with all the disadvantages of reproduction by mechanical finishing methods, this is evident in the examples given.

These examples also show the level which photographic art has now reached, its merits, and some of its deficiences. For instance, the landscapes of Mr. Hinton are as good representations of the actual natural scene as would be produced by any but the greatest artists in black and white and have an added merit of correctness, if that is required, while the not ungraceful figure by Mr. Collins of a nude girl sitting on a rock is a correct representation of the lady and the rocks—but not of much else.

PHOTOGRAPHY, ARTISTIC AND SCIENTIFIC. By R. Johuson and A. B. Chatwood. London: Downey and Co. 1895.

One principal difference between this and the many photographic handbooks now issued is the greater prominence given to the artistic side of the subject, indeed, the technical portion, instead of as is usually the case receiving exclusive attention, is kept quite subordinate. Instructions are given for exposure, developing, and the various methods of finishing. A chapter is devoted to photo-chemistry and one to apparatus, but the main object of the book, and a very worthy object it is, is to enable the photographer to produce pictures of a really artistic character. Special attention is given to protraiture, and a whole chapter deals with lighting and posing. Retouching, mounting, spotting, and enamelling are all carefully dealt with, as well as methods of finishing prints in monochrome and colour.

Another feature of the book which deserve mention is the excellence and abundance of the illustrations. Most of them are process blocks, but the effect of an enamelled print on gelatine paper is well given by means of Woodburytype, and a collotype print is employed to produce the effect of platinotype. The effect of retouching is shown by three pictures: one an untouched print, one partly retouched, and the third finished. In the same way the results of over and under exposure are indicated and the results of photographing colours on ordinary and on ultrochromatic plates, and with and without a screen.

Illustrations of the different classes of landscapes are given, some for the purpose of indicating faults, and in one case two methods of treating the same view are shown. There are even a few examples of snap-shots.

THE MANUFACTURE OF SOAP AND CANDLES. By Wm. Lant Carpenter. Second Edition. London: Spon. 1895.

This new edition of Mr. Lant Carpenter's work has been revised by Mr. Henry Leask, and contains a chapter on lubricants by Mr. J. V. Wilson. The book gives a very complete account of the theory and practice of the manufacture, including the raw materials used, the processes employed, and the various descriptions of soaps used for general and special purposes. A bibliography or list of works for reference is given at the end of the book, from which it will be seen that the author acknowledges his indebtedness to several papers and lectures given before the Society of Arts.

General Notes.

THE CURRENCY QUESTION.—A fourth edition of a valuable work prepared under the direction of the Senate Committee on Finance, and entitled, "Coinage Laws of the United States, 1792 to 1894, with an Appendix of Statistics relating to Coins and Currency," has issued from the Government Printing Office at Washington. The volume includes the paper on "The Currency Problem," read before the Indian Section of the Society of Arts on January 19th, 1893, by Mr. J. Barr Robertson. The only other paper reproduced is one on "The Future of Silver," by Professor Eduard Suess, of the University of Vienna, and member of the Austrian Parliament.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

DECEMBER 11.—ADJOURNED DISCUSSION ON MR. CUNYNGHAME'S paper on "Locomotive Carriages for Common Roads." J. WOLFE BARRY, C.B., Member of Council, will preside.

DECEMBER 18.—"Machines for Composing Letter-press Printing Surfaces." By JOHN SOUTHWARD.

Papers for meetings after Christmas:—

"Dairy Produce." By GEORGE BARHAM.

"The Making of a Great University for London." By PROF. SILVANUS P. THOMPSON, D.Sc., F.R.S.

"Some Native Irish Industries." By PROF. HADDON.

"Standards of Light." By W. J. DIBDEN, F.C.S.

"Stamboul: Old and New." By RICHARD DAVEY.

"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL.

"Madagascar." By CAPTAIN PASFIELD OLIVER.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"Supply of Sea-water to London." By FRANK W. GRIERSON.

"The Poster, and its Artistic Possibilities." By GLEESON WHITE.

"The Garden in Relation to the House." By F. INIGO THOMAS.

"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

"Punjab Irrigation, Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I.

"The Economic Development of Kashmir." By WALTER R. LAWRENCE, I.C.S., C.I.E.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Musical Pitch." By A. J. HIPKINS.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon at Half-past Four o'clock:—

DECEMBER 17.—"Jamaica." By FRANK CUNDALL, C. WASHINGTON EVES, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

W. WORBY BEAUMONT, M. Inst. C. E., "Mechanical Road Carriages." Three Lectures.

LECTURE II.—DECEMBER 9.—Second period of 19th century invention and enterprise—Development of steam road locomotives and traction engines—Design and construction—General principles: details—Highways and road locomotives Act—Slow development under oppressive restrictions.

LECTURE III.—DECEMBER 16.—Renaissance of public interest in mechanical road carriages—Recent inventions and achievements—Steam, oil, gas, and electrical carriages, vans, and cycles—French, German, and English vehicles—Passenger carriages—Goods carriers—Roads—Legal restrictions—Pending legislation, probable great importance of mechanical carriage manufacturing industry, and advantages to traders.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 9 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Worby Beaumont, "Mechanical Road Carriages." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Mr. R. Bruce, "The Influence of Locality on Breeds of Cattle and Sheep."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Lord Kingsburgh, "Electricity in the Dwelling."

Imperial Institute, South Kensington, S.W., 8 p.m. Capt. E. Stubbs, "Our Deep Sea Fisheries."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. F. Punchard, "The Working of the Agricultural Holdings Act, 1883."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Rev. Walter Weston, "Exploration in the Central Alps of Japan."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Dr. C. S. Patterson, "Enlarging by Artificial Light."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Carruthers Gould, "Sketches in Parliament."

TUESDAY, DEC. 10...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion upon the Papers by Messrs. Arnold and Wrightson, "The Physical Properties of Iron and Steel."

Photographic, 12, Hanover-square, W., 8 p.m. 1. Professor W. C. Roberts-Austen, "The Recording of High Temperatures by Photographic Means." 2. Mr. Chapman Jones, "A New Form of Apparatus for Measuring the Densities of Photographic Plates."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. J. Edge-Partington will exhibit some Ethnographical Objects from Matty Island, &c. 2. Mr. R. Etheridge, jun. (i.) "The Game of Teetotum, Queensland;" (ii.) "Notes on Australian Shields, more particularly the Drunmung." 3. Mr. R. H. Matthews (i.) "Stone Cooking-Holes and Grooves for Stone-Grinding, used by the Australian Aborigines;" (ii.) The Burbung of the Wiradjuri Tribes;" (iii.) "The Bora, or Initiation Ceremonies of the Kamilaroi" (Part. II.)

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. Justice Condé Williams, "The Future of our Sugar-Producing Colonies."

Asiatic, 22, Albemarle-street, W., 3 p.m.

WEDNESDAY, DEC. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned discussion on Mr. Cunynghame's paper on "Locomotive Carriages for Common Roads."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Discussion on "The Lessons to be learned from the Experimental Investigations by the State Board of Health of Massachusetts upon the Purification of Sewage," to be opened by Sir Douglas Galton.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, DEC. 12...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Arthur Diósy, "The New Far East—The Results of the War between China and Japan, and their probable effects on British Trade."

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. R. H. Harding, "British Life Assurance Companies and Colonial Legislation."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m.

FRIDAY, DEC. 13...Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Dr. Shield, "A Mechanical Device for Performing the Temperature Correction of Barometers." 2. Prof. Rücker, "The Existence of Earth-Air Electrical Currents."

SATURDAY, DEC. 14...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, DECEMBER 13, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 1 and 8, 1896, by Prof. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements, and Volcanoes."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue.

CANTOR LECTURES.

On Monday evening, 9th inst., Mr. W. WORBY BEAUMONT delivered the second lecture of his course on "Mechanical Road Carriages."

The lectures will be printed in the *Journal* during the Christmas recess.

TECHNICAL EDUCATION COMMITTEE.

A meeting of this Committee was held on Thursday afternoon, 5th inst., at 3 p.m. A report of the proceedings and a list of those present at the meeting will be printed in the next number of the *Journal*.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 11, 1895; JOHN WOLFE BARRY, C.B., F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Allison, Charles Arthur, 52, Chancery-lane, W.C.
Bosanquet, Charles John, Ripley-lodge, Belvedere, Kent; and 73, Queen Victoria-street, E.C.
Evans-Jackson, J. E., 45, Holborn-viaduct, E.C.
Oppermann, Carl T. J., 57, Wray-crescent, Tollington-park, N.
Plater, Captain Henry Robert Frederick, 18, Campbell-road, Bow, E.
Smallman, Frederick, Hayesleigh, Stretford, Manchester.

The following candidates were balloted for, and duly elected members of the Society:—

Johnson, George William, 47, Lincoln's-inn-fields, W.C.
Moore, Alexander William, Great Western Railway, Bristol.

The adjourned discussion on Mr. Cunynghame's paper, "Locomotive Carriages for Common Roads," was resumed.

The CHAIRMAN thought they would all recognise the great importance of the subject which was to be discussed that evening. The very able paper by Mr. Cunynghame, which was read at the meeting of 27th November, fully set before the Society and the public at large the various questions at issue, and described the stages of progress which had been made in the development of road carriages. All those who considered and could recollect the beginning of the bicycle movement, would at once see that in this country we were now at the beginning of a development of road locomotion comparable with the enormous change which the introduction of the bicycle and tricycle had affected in the powers of locomotion enjoyed by every human being. It was most startling to see the extraordinary ease with which people could now travel about the country either on business or on pleasure by the aid of the bicycle, which had given to the human animal almost a new power beyond anything that could have been foreseen 25 or 30 years ago. He could not help thinking that the same sort of progress would take place in this country in the development of the road locomotive. It was very well known, as Mr. Cunynghame had explained, that the difficulties which had taken place in the easy development of this system of locomotion were chiefly due to the restrictions of the Acts of Parliament, which at present fettered any real development of these very useful carriages. They all hoped that that state of legal disability would soon be greatly modified, and that they would before long see the field thrown open for inventors to produce carriages which would be allowed to traverse the streets and roads unfettered by those very old-fashioned and restrictive conditions which at present stopped all progress. To that extent he was sure they would all wish the greatest success to Sir David Salomons in the inauguration of a society for the protection of those who saw how much there was in the future in the direction he had indicated.

Mr. A. H. BATEMAN said the remarks which he should be able to offer were chiefly of a historical character, inasmuch as the steps which he took, in conjunction with some few others, 14 years ago, brought the matter to an issue as far as it was concerned, but it was an issue of stoppage. The Act known as "The Highways Act," was passed many years ago, before the days of bicycles and tricycles with thin light wheels and rubber tyres, and it was mainly intended for the protection of common roads and for those using the roads, and, of course, could by no stretch of imagination have been intended to apply to carriages which had never been thought of, and were scarcely even creatures of the fervent imagination of inventors yet to come. But, however, the law existed; carriages propelled by steam, or other than animal power, were to be restricted to a certain width of wheel, a certain minimum number of attendants, a certain speed per hour, and must have a red flag. His experiments had been made with a view of applying steam-power to tricycles mainly; and these experiments were carried out with very fair success as evinced by the machine which he had the honour of exhibiting in motion a fortnight ago, and which was still to be seen in the vestibule of the Society. That machine had all been broken up, but to oblige Mr. Cunynghame the various parts were brought from his museum of antiquities, some even from the scrap heap, and rather to his surprise, the thing was got to run, and it was found that the boiler would raise steam of 150 lbs. pressure from cold water in 2½ minutes. With benzoline spirit, which was used fonrteen years ago, it took four minutes to raise the steam. It was probably in the knowledge of many that the law was invoked in order to see whether these things could not only be made but used. It was absurd to think that engineers were going to put capital into a business of this sort, to make articles which buyers could not use except in private grounds. Sir Thomas Parkyn, who had one of these machines, was brought before the Greenwich Magistrate and fined 1s. for using it; and when the matter was taken to the Court of Queen's Bench, the Court would not listen to any argument to prove that the House of Commons could scarcely have legislated for a thing unborn. The Court simply said the law was there, and that it was its duty to administer it, and not to comment upon it. The result was that the conviction was confirmed with costs, and this, of course, stopped the manufacture. As the result of a very enthusiastic meeting, presided over by Sir David Salomons, held the previous day at the Cannon-street Hotel, resolutions were passed to form an Association to look after the general interests of the new industry, which undoubtedly was going to be created shortly, and Sir David was elected president of the Association. Great stress was laid on the fact that this would practically go a long way to meet the question of light railways. There were many means by which this desired end might be attained. One of these means was steam, which was by far the oldest. The next means was petroleum or electricity, and even clockwork with springs. The latter, of course was practicable, but only for short distances, and as the weight must always be considerable, that means might be at once dismissed. At the present moment the fashion tended towards petroleum. He should not say anything about petroleum engines as he knew very little of the subject, though he understood there were several gentlemen present who could say a great deal in their favour. Electricity was objected to on account of the weight required to store it, and the great difficulty of getting it replaced. Quite recently a statement had been made that the long hoped for end had been obtained of storing electricity in something lighter than lead sheets. If that proved to be true, then steam and petroleum would have to look to their laurels. It would be interesting, perhaps, to hear a brief description of how the steam-propelled carriage was left 14 years ago, when the Highways Act put an effectual stopper upon the business as a commercial undertaking. To an ordinary tricycle, before the days of pneumatic tyres, was affixed a little old-fashioned double-cylinder engine, the boiler consisting of a number of thin copper tubes of ⅝ diameter, bent in the shape of the letter W with the points taken off, and the two ends expanded into a casting. A full description of this machine would be found in the *Autocar* newspaper. The general idea was the production of a very small quantity of steam in a given space, so that in the event of the main tube giving way there would practically be no injury to any person standing near; and the second idea was to get up steam very quickly. By using distilled water, over and over again, the tubes were kept clean. The water was kept cool, and this wat effected by passing the steam through a small condenser. The net result was that you could light the furnace fire, and in four minutes start with a pressure of 150 to 200 lbs. of steam, and the machine could be run at any speed you liked. It could also be stopped without jolt or jar. As the steam pressure rose, if it was not used, it automatically shut off a number of burners, leaving only 3 out of 21 alight, and the machine could be started by turning the handle, when the burners would be turned on and the steam raised again to working pressure. A speed of ten miles an hour was attained on level roads. Although the machine was heavy and complicated, it did its work. Starting from that standpoint engineers could very easily improve upon what had taken place, and turn out satisfactory steam-carriages if they were only allowed to use them. Steam was free to everybody, as all the patents had expired. This industry, if allowed, would form an important counterweight to the claims of those who were bringing forward admirable new machines, and in the interest of the public it would tend to keep the prices down, and the machine might fairly compete even with the new petroleum-engines. If he were free to choose between the three forms he thought he should choose petroleum, though he thought more energy and enterprise had been expended on petroleum than on steam. In these days of rapid advance, when they had got such engineers as Sir Frederick Bramwell and Mr. Wolfe Barry, to preside over these meetings, he thought it showed that they believed there was a great future for the new machines and possibly for the employment of a large number of men who were now out of work. He ventured to think that there was a great foundation on which to start, but he did hope that steam would not be altogether left out. The only fault against steam was that the machines could be made to travel too fast. He hoped that the result of the meeting would be that they would not be too much restricted in this new power, but every man, woman, or child running a mechanically-propelled carriage must take the consequence of what they did, and under the common law, if they did damage, they must pay for it. Of course, if they were to be licensed and inspected, it would be the old story over again which the railways had fought against, and which, if it had been successful, would have compelled them to work with steam at 40 lbs. a square inch instead of 280 lbs., as they were now doing.

The SECRETARY read the following letter from Prof. C. V. Boys, F.R.S.:—"I regret extremely that in consequence of a prior engagement I am unable to be present to take part in the adjourned discussion to-night. Perhaps I may be allowed to join with those who have gone before in both congratulating Mr. Cunynghame on the clear way in which he has brought the subject before us, and on the beautiful series of views which he has used to illustrate his subject. I feel very strongly that Mr. Cunynghame has not exaggerated the importance of this subject. However much we may admire the ingenuity and construction of the machines produced on the Continent, my view is that the country which has made the practical success of the bicycle and tricycle, in which excellence of design in each detail and manufacturing perfection have contributed to the success so largely, is the most likely country to get rid of the objectionable features at present existing in these horseless carriages, not excluding the United States, that is, if we may allow Mr. Maxim to be in England, if not an Englishman. England, or rather Great Britain and Ireland, is I believe best fitted and best able to revolutionise our present ideas as to methods of horseless transit, and will do so when the absurd law on the subject is abolished. Mr. Maxim has told us that he has had a complete scheme in his head for driving road-carriages by motive power. No man is probably so competent, but he is engaged in a grander problem, and I, for one, should be sorry if he should desert the problem of conquering the air for the more prosaic one of moving on common roads. With respect to large cities such as this, I can imagine no boon so great as that which perfection in horseless carriages will give us; I mean perfection which, with respect to the machines exhibited, will be as great as the perfection of the modern bicycle is with respect to the boneshaker of my early days. I know it is dangerous to prophecy or to indicate great possible changes; in fact, the community at large are not competent to form an opinion upon conditions of life which differ widely from those to which they are accustomed. The ridicule excited by the early railways and steamboats, and the equally prevailing ridicule with which proposals for sanitary decency would be received in many quarters in South Europe at the present time illustrate what I mean. So now the possibility of a busy city with clean roads not perpetually closed for repairs, in which every vehicle, cab, cart, or van, would move noiselessly and automatically and cheaply as directed, in which no horses or beasts of burden are permitted, seems ridiculous also, but it is not ridiculous if such a success as I have indicated is obtained. I am not competent to deal with the question of cost, but I think it is not an absurd proposition that the reduced cost of cleansing and repairing roads, and the increased comfort of existence under the projected circumstances, would more than balance any increase in expense which these horseless carriages might entail. Possibly, if every vehicle were automobile, and were fitted with rubber or with (better) pneumatic tyres, there would still be a money gain to the community at large with incidental advantages too great to contemplate. Let beasts of burden and coal be abolished from a city and let gas, electric power, and water be supplied from a distance, and let the traffic move itself, and a great place like London might still be clean and fit for human habitation. However, leaving dreams—as I fear these will be considered—alone and returning to the present state of affairs, it is satisfactory to note how much is already possible. Indeed, our ideas will be changed and these machines must be simple and easily managed if what Mr. Cunynghame tells is true, namely, that by their aid our young men will be able to take into the country their wives and, perhaps, their sweethearts with them."

Mr. J. B. CARSE said he had read Mr. Cunynghame's paper with great interest, and had also looked over the discussion which followed, and before speaking of the Pennington engine, he would like to deal with some of the remarks which had been made. First steam was spoken of, and one gentleman said that the great advantage of steam was that it could be easily controlled, and he raised the objection to petroleum-engines that they had to run at the maximum power and no less. But he claimed that these engines had been so perfected that they could run either at the rate of 1,000 revolutions a minute, or 4, 5, or 6 revolutions. He had some experience of steam-engines, and some ten years ago he was engaged in building a railroad velocipede to run on the track for the inspector. For that purpose he used a two-horse power engine, the pistons coming straight down through the car to the driving wheels; three horse-power boiler with kerosene oil for fuel. A very good speed was obtained; but the great objection was the heat from the boiler, although it was covered with asbestos. The company were also interested in electric launches, having built those in use at the World's Fair at Chicago. These were 35 feet long, and each had a three horse power motor. They required 72 cells; the weight of each was 40 lbs., and it took about eight hours to charge them. Coming now to petroleum-engines, those of the ordinary construction weighed about 1,000 lbs., and developed about two-horse power. They were operated in one of three ways, either by a flame, by an incandescent tube, or by an electric spark, to explode the gas. The engine which he now showed them, which was used for a bicycle, developed two-horse power, and weighed about 20 lbs. This was known as the Pennington engine. Something having been said against high speed, he would not say how fast they could drive it, but, as an illustration, he might say that Mr. Overmann, who built the Victor bicycle, sent a man to see these engines. He was a little sceptical about the speed, and said he should like to take his light racing machine and try its speed against it. They put a man on their machine; the two started about twelve blocks off, and by the time the Pennington motor had arrived at its destination, the other man had only proceeded about one block, and he arrived quite out of breath, and said he was satisfied. The engine he now showed had been run several days in the testing-room without a water-jacket, which they dispensed with as it was always an objection to this kind of engine. The reason they could do without it was because they took advantage of the same scientific principle which was operative in refrigerating machines in various kinds, *i.e.*, the principle of evaporation. The oil was admitted into the cylinder and vaporised, and the rapid vaporisation kept the cylinder cool. They claimed to obtain perfect combustion, nothing coming out of the exhaust, that is to say, there was no perceptible smell. With regard to controlling the speed, it had been said that a gas-engine could not run over 400 or 500 revolutions without missing fire if electricity was used, but with this engine they could run 2,000 without a miss, the reason being that they had a perfectly explosive gas in the cylinder, and there was no missing. The speed could be controlled as desired by the simple method of regulating the amount of oil which was admitted into the cylinder for vaporisation. He had ridden a great many hundred miles on a vehicle propelled by such an engine. They used 4-inch pneumatic tyres, made by Messrs. Morgan and Wright, which it was impossible to puncture; the tyre was fixed mechanically to the rein, so that it could not be displaced. For a vehicle holding two people they used an engine with a fly-wheel weighing about 120 lbs., with which they could make a speed of 20 miles an hour. The motor consisted of two steel tubes, each 2½ by 6 inches, and having a tensile strength of 8,000 lbs. to the inch. With an ordinary gas-engine a fly-wheel was required, but in this instance the engine was so attached to the bicycle that the driving-wheel took the place of the fly-wheel. Any kind of petroleum oil, kerosene, crude oil, or gasoline could be used. As he had already said, the speed was controlled by the supply of oil, and no matter how much the supply was diminished, the manufacture of gas still went on in the cylinder. Some question had been raised as to the air-propeller, and he might say, therefore, that he took one of these bicycles, extended the crank shaft, and attached to it an air-propeller, 32 in. in diameter, and it drove the bicycle at a very good speed. They then took it down to the river, placed it in an 18-inch launch, and drove ahead, both up and down stream, about six miles an hour, with the same 32 in. propeller, and the boat seemed to go at the same speed as if an ordinary water-propeller had been used.

Mr. JOHN PHILIPSON said this was a subject of the greatest importance to all interested in locomotion. As a carriage manufacturer, he looked upon it with the deepest interest, and could not but say that it was a serious question whether it was likely that the motor would supersede the ordinary carriage. The first thing, of course, was to have the restrictions of the Highways Act removed before any development could take place; but he thought the society just started at the meeting over which Sir David Salomons presided, was of such an influential nature that the Board of Trade would soon have to meet their wishes. Upon these restrictions being removed, he believed that the engineers and carriage manufacturers would at once devote their attention to producing a vehicle suitable, not only for the carrying of passengers, but also of farming produce and other merchandise. As an old agitator on the carriage tax, he should like to say that he believed that if Mr. Knight's case had been thoroughly worked up by practical experts, a different decision would have been arrived at. When the last Assessed Tax Act was passed, a special provision was made for mechanical carriages at a license of two guineas, and his opinion was that if Mr. Knight had taken out his license he might have used his carriage provided he did not incommode the ordinary traffic on the roads. He still held that opinion, but as there was some doubt about it, it was as well that an Association had been formed to deal with the matter, and there could be little doubt that the restrictions would soon be removed. At the same time, if facilities were given, the use of such carriages must be properly safeguarded. There must be some security for good workmanship, and regulations would have to be made as to speed and other conditions, so as not to interfere with ordinary traffic. He was quite sure there was sufficient talent in England, especially amongst the young men, to enable them to devise carriages of this description which would hold their own against those produced either in France or America. He should watch with the deepest interest the motor which had been referred to as of two horse-power.

Mr. CARSE said if the speaker had any doubt about its capabilities, he should be happy to demonstrate its utility by giving him a ride upon the bicycle.

Mr. PHILIPSON said it seemed somewhat extraordinary to talk of running a cycle at the rate of sixty miles an hour; but, assuming that to be so, some restriction would have to be put upon it for the sake of travellers on the main road. He thought the day had come when a mechanical carriage was necessary for Great Britain. Somehow or another they had quite forgotten the country districts. Trunk lines had been built, but there were many villages 15 to 20 miles from those lines, and the ordinary carrier's carts which formerly existed in many places had ceased to run, so that if agriculturists were to have facilities given to them for the conveyance of their produce a mechanical motor would have to be introduced, and he had no doubt that everyone would give their best attention to develop a vehicle to meet that pressing want. The reason mechanical carriages were not developed fourteen years ago was because they had not the improved springs to balance weight or to relieve concussions, but now they had the indiarubber tyres and pneumatic tyres. It was perfectly surprising how the pneumatic tyres four inches in diameter would run over fresh cut stones without being in the slightest degree injured. He was inclined to think that the more the diameter was increased, the less chance there would be of puncture. Improved springs and pneumatic tyres would make the mechanical carriages of the future a great success, and these were the points in which carriage makers could aid engineers in perfecting a vehicle which would hold its own against all comers. He came from a town where the name of Stephenson was held in the highest honour and the same talent which in byegone days revolutionised the world, could still be found upon the Tyneside. He trusted that the present gathering would give a stimulus to them in putting their wits to work to bring out a motor which would bear comparison with any other. He doubted whether it would be an oil motor or a paraffin one; his leaning was rather to steam, or to some improvements in the use of electricity. Compressed air might perhaps be the medium. So soon as the existing restrictions were removed by Parliament the minds of many would be at once set to work upon the subject. Some years ago the rage was all for cheapness but if mechanical carriages were made cheaply their success would be endangered. The work of the carriages must be of the most superior kind. As Lord Derby once said, technical teaching was all well enough if only you could get the people to appreciate a good thing, but to teach youths to do a thing in an imperfect manner was highly improper, and to teach them to do them well and not to get a paying price was not satisfactory. It had been said that if mechanical carriages were introduced the demand for horses and pleasure carriages would be reduced, but his own opinion was that there would be the same demand for both. In the time of George Stephenson it was said that horses would soon be a drug on the market, but, so far from that being the case, the price of horses was now higher than ever. Again, it might be recollected that when cycles were introduced it was thought that the use of private carriages would be lessened, but this was not so, although there were now over 1,000,000 cycles and tricycles in use in Great Britain. By giving people facilities to travel, the wish to travel grew upon them, and instead of lessening the demand for even pleasure carriages, the motor carriage would turn out to be merely a feeder for it.

Mr. ALEXANDER SIEMENS said the question of motor carriages was very much in the air now, as was evidenced from the fact that Cantor lectures were now being delivered on the subject, in addition to which they had an important meeting in the City the previous day besides the paper which they were now discussing. Mr. Cunynghame had said there were some good mechanical inventions for propelling bicycles, and now they were introduced to the two-horse power motor, which seemed to be such an improvement that the last speaker almost doubted whether it could be true. The moment engineers and carriage builders had a chance of turning their attention to the subject he believed they would be able to produce a marketable article. If the public would only take up the idea there would be no question that they would soon see a very great improvement. From the moment electricity was taken up by the public, and the obstacles which stood in its way were removed by the Legislature, very rapid advance was made in the science, and the same would be the case with motor vehicles. The first attempt he considered ought to be made upon the heavier vehicles. Everyone had spoken in favour of powerful machines being more easily and economically made, and if this was so he thought experiments should be made with the view of seeing whether mechanical means for propelling omnibuses could not be substituted for horses. It was too difficult to prophecy upon the subject, and, therefore he would much prefer not to say what developments ought to follow this.

Mr. R. EDWARDS said there was one point which seemed to have been totally lost sight of. Everybody deplored that the Act kept down speed to four miles an hour, but the real reason that the Act was passed was because owners of vehicles ran them about the country at an excessive speed, and it was feared that as traction-engines were just then coming to the front, their use would entirely stop locomotion on the roads. The result was that certain farmers and the late Mr. Thomas Aveling of Kent, got together meetings, and from the resolutions there passed the Act was obtained. This Act was passed in good faith, and for a wise purpose, but he thought the time had now come for repealing it. If the speed was kept down to, say, ten miles an hour, he believed the results would be satisfactory.

Mr. C. H. YEAMAN said the paper was an admirable one, but the mention of electricity had been eliminated from it. It was true reference had been made to the Pioneer Company having undertaken some experiments; but he was sorry to see no mention made of the trials, extending over nearly two years, involving the running of electrical vehicles some thousands of miles in the streets of London in 1888. He was the works manager of the company which built a large number of electric vehicles. It was true sundry obstructions occurred, and the attention of the public was attracted to electrical omnibuses, more particularly by accidents, where the omnibus found its way against certain lamp - posts and pillar - boxes. But this only took place in the first three months. Within six months of the first start the steerage gear and other mechanical devices had been perfected, and beyond the excess of exertion which was required for steering it performed its function admirably. Mr. Siemens had said the heavy class of work should be attacked first; and the Ward Company had the intention—though from circumstances beyond their control it had not been carried out—of undertaking a considerable business with heavy vehicles. Several schemes were entered into for the cartage of dust in the streets. In any case experiments made with accumulators of the weight they then were, showed results proving that a fair scale of cost per mile from an electric omnibus carrying 26 passengers was certainly no more, and probably less, than 3d. On a small scale the cost is greater, but the experience gained by running that omnibus was sufficient to prove that with accumulators, light carriages could be run successfully if the necessary conditions were present. In the course of running some 5,000 miles—and he personally had experience of some 3,000—he had experience of all kinds of conditions in the roads met with in London, and he went over most of the gradients, and the result was that, under proper conditions, there was no reason why electricity should not be used, even with the present accumulators, without waiting for the problematical light weight ones. Of course trained electricians and engineers were necessary, or such a line of omnibuses could not work satisfactorily; the whole question lay in organisation. The wear and tear of the accumulators was considerable, and, admitting that it was much greater than one was accustomed to in private - house lighting, the hospital work of such a company would be considerable, but, given a proper organisation for the repair of the cells, there was no reason why an omnibus should not be run from Hammersmith to Liverpool-street as a commercial venture. For reasons he need not enter into, the line of omnibuses often foretold, and often arranged for, had not yet come on the roads; but Mr. Bursley, whose name ought to be mentioned in this connection, who was his successor, had since taken up the question; and he believed that within a short time they would see some movement on the part of the Ward Company. But the history of the electric traction on common roads went back very much further. Many would remember the electrical tricycle which was shown in the Albert Hall in 1883, and the electric car in Brighton in 1886. Nothing further came of it than the forming of the Ward Electric Car Company in 1888. Since then another omnibus had been built on an improved type, a little less like a prison van, and it was at that moment stabled not more than a mile from there. What experiments would be made with it he could not say, but anyone who would have the privilege of taking a trip through the London streets in such a vehicle would not be inclined to condemn accumulators even in their present condition. With regard to legal restrictions, first of all, Mr. Ward took out a license, and the 1888 omnibus was the first licensed electrical vehicle to run on common roads. They communicated with the Board of Trade to know if they wished any alterations, but nothing came of that. They were also on the most friendly terms with the police, but the only trouble they met with was the occasional damage which was done. No obstacle was placed in their way by the authorities. But then they did not ask the authorities whether they were permitted to run; having taken out a license they took it for granted that no restrictions would be placed in the way. For rural districts, where you were away from charging-stations, probably oil, steam, or some other form of motive power would be most useful, but for urban districts, where the roads were good, the gradients moderate, and charging-stations available, he thought accumulators would be successful. The weight required in order to run a full-sized omnibus the double journey would be about 1,600 lbs.; 56 cells, of about 56 lbs. each, gave a run at full speed of about 3 hours. The omnibus weighed, complete, about 5½ tons, and the omnibus loaded would not be very much heavier than when it was empty. If the weight of the passenger load was considerable, the weight of the accumulators did not matter so much, but if you wanted a light vehicle to run with a very small load he did not see how accumulators were going to do the work.

Mr. CLARKSON said it had been stated by Mr. Carse that the tensile strength of the steel cylinders was 8,000 lbs.; he thought it must mean the pressure inside. A strength of 8,000 lbs. to the square inch was about four tons, and that could not be the strength of the steel. It must mean the working pressure. A 2½ inch tube ⅛ inch thick certainly ought to stand 8,000 lbs. internal pressure. He had recently begun some experiments on the internal bursting pressure of steel tubes, and up to 7,000 lbs. per square inch, a tube of about half the dimensions of that showed no signs of distress. He should like to know what was the work pressure at the time of explosion. Then it was said that this little engine was of two-horse power, and would run 1,000 revolutions a minute, consequently, when running 500 revolutions it would only have one-horse power, and at a speed of 100 revolutions the power would only be one-fifth horse-power—was that correct.

Mr. CARSE said the power was two horse power at 500 revolutions.

Mr. CLARKSON said in that case it followed that when running at a slow speed it did proportionately reduce the power developed, but for hill climbing you wanted all the power when you could not run the engine at full speed, and that point must not be lost sight of in the application of such engines to heavy traffic. Another question was whether these engines could be reversed, because although 90 per cent. of the work was done in a forward direction, they did want to back and be able to restrain and control the movements of the carriage in all possible directions. The question of legal restrictions had been touched upon several times; and he hoped before long, they would be in a position to go ahead; but still it was desirable that everyone concerned should be properly protected. From an engineer's point of view, the factor of safety must be very great. He must refer to the action of the authorities of the *Engineer* competition, who notified that no oil used must be of a lower specific gravity than ·8, or of a lower flashing point than 75, and he thought this was a step in the right direction. These vehicles would not be run by skilled engineers, but would be placed in the hands of people of ordinary intelligence, and possibly in some cases of less than ordinary, and any accident would seriously injure the movement. They could not afford to have accidents. The carriages must be so well designed, and made so strong, that the risk of accidents should be practically eliminated. He hardly liked to suggest that when the Bill was drafted, the employment of light oils should be prohibited; but he certainly thought it would be a wise step. As to the inspection of carriages, it was a difficult matter, which would to a large extent adjust itself, because if any maker put on the road a badly-made carriage he would soon be out of the business. It was the interest of everyone concerned to make a good thing; but it might be desirable, in the first instance, that these carriages should be inspected by Government.

Colonel CUNNINGHAM said there was one point about the Pennington engine which he should like further explained. They were told that one great advantage was that it burned all the oil it used, but later on, that the means of reducing the speed was by reducing the quantity of oil taken into the cylinder; and nevertheless the means of explosion was so perfect, that it always acted properly. He should like to know whether in all these cases the oil was perfectly consumed. Then there was a question as to the relief of the traffic when these machines were introduced. Some relief would be got from the heavy traffic in the street possibly by the shortening of the total length of the vehicle in consequence of the motor being placed on or under the carriage, and the space saved which was now occupied by the horse. A great deal had been said of the risk of those interested in horses being frightened that their trade would be interfered with. But there was really no ground for such apprehensions. When the underground railway was opened, it was supposed it would greatly interfere with the number of horses used. But this had not proved to be the case. There were far more horses, omnibuses, and cabs used now than there were then. One speaker had referred to the price of horses not having fallen. But he thought the real question was the number and not the price. The truth was, the population increased much faster than the facilities for traffic. It would be the same twenty years hence. Even if this new system was introduced now, by the end of twenty years some further mode of relief would be required. Remembering that his friend who read the paper was formerly an officer in the Royal Engineers, reminded him of the possibility of the application of these motors to military purposes. There were already cyclist corps attached to the Volunteers, and no doubt when these motors became a practical success, and did not fall out of repair easily, they would be introduced for military purposes.

Sir H. **Trueman Wood** (Secretary) said since the meeting began he had received a copy of a Chicago paper containing the result of the competition held there, and this it would be no doubt interesting to the meeting to hear. It would be remembered that the *Times - Herald*, of Chicago, offered a sum of 5,000 dollars, or £1,000, in prizes for horseless carriages, to be tried over the road from Chicago to Milwaukee, a distance of about 80 miles. He did not know what the road was like, but if it were anything like the ordinary roads of Western America, it certainly would be one which would afford the most efficient test of any carriage tried over it. As originally arranged, the trial was to take place on November 2nd, but it was postponed by mutual consent, and a consolation prize of 500 dollars given, which was awarded to a motor carriage invented by the Müller Company, which was the only one which went over the shorter distance then arranged. The competition was postponed to November 28th, and on the day before eleven carriages were entered for the race, but only six started, four driven by petroleum, and two electric. The course was from the south side of Chicago, round the outside of the town to Evanston, about thirteen miles to the north, over the magnificent line of boulevards and streets which encircled the City. Of the six that started two only finished, both petroleum carriages. The first was the Duryea carriage, and the second the Müller, which won the previous consolation prize. The distance was about 54 miles, and the time taken by the first carriage was a little over ten hours. It is only fair, however, to say that the weather was extremely bad, and there was heavy snow, so that the conditions were most unfavourable and the test a very severe one.

Mr. **Carse**, in reply to a question, said the Pennington engine vehicle had been already shipped to this country, and therefore did not compete on the occasion referred to.

Mr. W. **Worby Beaumont** said he should not have risen to speak on this occasion, having other opportunities of expressing his views, but it seemed to be generally assumed that they were going to get these legislative restrictions very easily removed, and he wished to impress upon all interested that unless everyone did his best, it was very likely that the Bill would not go through. Sixty years ago a great deal had been done, for their forefathers were very successful with steam-carriages, and there was sufficient evidence and support by the makers of those things to cause the Government to appoint a Select Committee to consider the question; that committee went into the matter very thoroughly, and reported as favourably as any committee could at the present day with regard to vehicles it was possible to make now, but it must be remembered that up to the present time those who were expected to be opposed to facilities being given had not spoken, and it was not until the Bill came before Parliament that they would know the strength of the opposition. It must not be assumed that the Bill would go through very easily. The memorial prepared by the proprietors of the *Engineer* had been signed already by 1,700 individual firms and individuals, and had now been presented, and Mr. Chaplin, the President of the Local Government Board, stated that personally he was strongly in favour of the movement.

Mr. T. H. **Brigg** said the Chairman had referred to the fact that thirty or forty years ago no one foresaw how people at the present day would be running about with such comparative ease on bicycles. Now if the engineers of thirty years ago could have met on behalf of horses, or if 6,000 or 7,000 years ago such a meeting had been held, they would have found vehicles running about the streets to-day with far greater ease and economy to the extent of some millions per annum saving on what they cost at present. If they only knew why it was that they could transport themselves from point to point with such great ease on the wheels of the cycles, and why it cost so much energy to walk on our own feet, they might appreciate the question he wished to put—Why should they insist to-day that a horse should necessarily carry a great weight on his back? A man likes to be carried and not to carry, and the same thing was applicable also to the horse. He would therefore ask, on behalf of the horse, that engineers would take into consideration those principles which would lead to economy, in horse carriages, and in any other mode of locomotion.

Mr. **Cunynghame**, in reply, said it had been suggested that he had not said anything about electrical vehicles, but in the paper, the work of the Pioneer Company was mentioned, and it was impossible to go into minute details of what it had done, as they had not yet been published.

Mr. **Yeaman** said the Pioneer Company was formed some years after the Ward Company.

Mr. **Cunynghame** said he must apologise if he had not given all the information he could possibly have obtained, but he had endeavoured to do so. He could only say that he wished every success to electricity, and if they could only get a light accumulator, that would probably be superior to anything else, but having given what attention he could to the matter, and having seen some of these carriages, it did seem to him that the great weight which it was necessary to carry about to store up a sufficient amount of power was a very great drawback; and it must be borne in mind that great weight in the carriage militated against the use of pneumatic tyres. He could not help believing that the carriage of the future would be made with huge pneumatic tyres. The difference between that and the ordinary carriage might be compared with the effect produced by rolling a small heavy ball on a road as against a large soft ball; the one ploughed through the inequalities of the road, while the other gently skipped over them. Putting it in a familar way, that was the real cause of difference between the common wheel and the pneumatic tyre. The ease of the pneumatic was due to the way it yielded instead of smashing over inequalities. The future of these carriages to a great extent, and particularly for military purposes, would be found in the intelligent use of the pneumatic tyre, and as lightness was the principal point, electricity was therefore handicapped. Electricity would not be handicapped as applied to tramways, or for use in towns paved with wood pavement or the like. The next important point was the carriage tax. Agricultural locomotives did not pay the carriage tax. The Act provided that all carriages drawn by horses or by mechanical power should be taxed, so that it was evident the persons who framed the Act discriminated between a heavy locomotive and a light carriage. He had tried to find out the reason for this, but without success, as the persons who framed the Act were dead. His own opinion was that the words had slipped in from an old Act. The Judges who decided Mr. Bateman's case took the point into consideration; it was not omitted from the judgment of Lord Coleridge, for the judges said that notwithstanding that point they did not think it was sufficient to take the case out of the Act. One other point which he should like to mention was the fact that these carriages were treated as nuisances. To explain what he meant, he would take the following instance. An Act of Parliament gave a railway power to run a locomotive on a line of railway, which line happened to be close to a road, and the locomotive as it came puffing along, frightened horses; if the locomotives were not licensed to run by an Act of Parliament, the frightening of the horse would give a Common Law right of action, but inasmuch as they were permitted to run by the Legislature they had a right to do a thing impliedly in the ordinary way, doing as little harm, and committing as little nuisance as possible. Shortly after the Act was passed, locomotives did run upon a line close to the carriage road, and a horse having been frightened, an action was brought, with the result that the company were held not to be liable. When the Locomotive Act was passed, it would have been argued that locomotives had a right to run along the road, and provided they frightened a horse so much the worse for the horse, but by a clause specially put in it was provided that all rights against them in respect of nuisances at Common Law would remain as if the Act had not been passed. Therefore, they had this result, that a railway company was not liable, but if the auto-car frightened a horse the owner of the car would be liable. In the case of a stage-coach frightening a horse the owner would not be liable. This was a point which might give rise to considerable difficulty unless it was specially provided for in future legislation. With regard to what had been said of driving 60 miles an hour he might mention that last Sunday he saw a bicycle running down the main Portsmouth road at a speed of certainly 35 miles an hour, and the rider did not seem to be much the worse for it. If a man were on a lonely country road he might, with good pneumatic tyres, ride 40 miles an hour, but, of course, speed like that ought not to be allowed in towns. When the word tensile strength was used with regard to the Pennington engine, what was meant was that the stress put upon the material of which the cylinders were composed had been calculated never to exceed 8,000 lbs. The steel was much stronger than that, but the total tensile strain put upon the steel was never to be greater than that. Taking the area of the steel in the cylinder, and calculating it with the piston, one could calculate what the greatest force per square inch in the cylinder at any given time was.

The CHAIRMAN, in proposing a hearty vote of thanks to the reader of the paper, referred to the great encouragement which those who were interested in this mode of locomotion must draw from the fact that Mr. Cunynghame had given them so valuable a paper. It must also be a subject for congratulation that Mr. Cunynghame was officially connected with the Home Office, and was, therefore, not only able to take a view in his private capacity, but had also an opportunity of considering the question from that official position, which enabled him to see that there were many sides to it. No one could doubt that some restrictions were required as to the mode in which steam locomotion, or oil-driven locomotion, or electric locomotion might be applied to common roads. what they had to look to was, that those restrictions should be confined to what was reasonably necessary for the safety of the public. No body could doubt that at the present time the restrictions laid on the development of this very interesting industry were simply ridiculous; that they were behind the times and placed this country in an absurd position as compared with almost every other civilised country. Within the last few months, while staying in Paris, he saw many auto-motors travelling some of the most crowded streets with the greatest facility. If that were possible in Paris it did seem absurd that it should not be allowed in the United Kingdom. The only thing to be done was to agitate and agitate as some other person had said before in a similar case where the law required to be altered. The restrictions which at present fettered a most useful industry would have to be removed.

The vote of thanks was passed unanimously, and the meeting adjourned.

General Notes.

CIDER.—Mr. C. Radcliffe Cooke, M.P., who read a paper on cider before the Society of Arts on March 6th, 1895, has written a long letter to the *Times* which is commented upon in a leading article on December 9th. Mr. Cooke says that the apple harvest has been so plentiful this year that an attempt has been made to turn Kent into a cider county. The main object is to make good cider, and lectures are being delivered in order to give instruction to cider makers in the scientific branch of the subject. The National Association of Cider Makers have resolved to apply to the county councils of cider-growing counties for grants in aid of instruction in cider making.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evening, at Eight o'clock :—

DECEMBER 18.—"Machines for Composing Letter-press Printing Surfaces." By JOHN SOUTHWARD. W. C. KNIGHT CLOWES, M.A., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon at Half-past Four o'clock :—

DECEMBER 17.—"Jamaica." By FRANK CUNDALL, C. WASHINGTON EVES, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

W. WORBY BEAUMONT, M. Inst. C. E.,
"Mechanical Road Carriages."

LECTURE III.—DECEMBER 16.—Renaissance of public interest in mechanical road carriages—Recent inventions and achievements—Steam, oil, gas, and electrical carriages, vans, and cycles—French, German, and English vehicles—Passenger carriages—Goods carriers—Roads—Legal restrictions—Pending legislation, probable great importance of mechanical carriage manufacturing industry, and advantages to traders.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Worby Beaumont, "Mechanical Road Carriages." (Lecture III.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. W. A. Herdman, "How they Rear Oysters in France."

British Architects, 9, Conduit-street, W., 8 p.m. Dr. Max Ohnefalsch-Richter, "Græco-Phœnician Architecture in Cyprus, with Special Reference to the Origin and Development of the Ionic Volute."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arnold Mitchell, "Early Norman Churches."

TUESDAY, DEC. 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Foreign and Colonial Section.) Mr. Frank Cundall, "Jamaica in the Past and Present."

Civil Engineers, 25, Great George-street, S.W.

Statistical, United Service Institution, Whitehall, S.W., 5 p.m. Dr. Arthur Newsholme, "A National System of Notification and Registration of Sickness."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. 1. Mr. E. J. Wall, "Notes on Colour Printing." 2. Mr. C. G. Zander, "Note on the Printing Ink."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. F. Hampson, "The Classification of the Moths of the Subfamilies *Schœnobiinæ* and *Crambinæ*, of the Family *Pyralidæ*." 2. Mr. Oldfield Thomas, "*Cœnolestis*, a still existing Survivor of the *Epanorthidæ* of Ameghino, and the Representative of a New Family of Recent Marsupials." 3. Mr. Walter E. Collinge, "The Sensory and Ampullary Canals of *Chimæra*." 4. Mr. F. A. Bather, "The Fossil Crinoid *Uintacrinus*."

WEDNESDAY, DEC. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John Southward, "Machines for Composing Letter-press Printing Surfaces."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Notes on some of the Differences between Fogs, as related to the Weather Systems which accompany them." 2. Major H. E. Rawson, "Analysis of Greenwich Barometrical Observations from 1879 to 1890, with special reference to the Declination of the Sun and Moon." 3. Mr. Stratton C. Knott, "Meteorological Observations taken at Mojanga, Madagascar."

Geological, Burlington-house, W., 8 p.m. 1. Sir Archibald Geikie, "The Tertiary Basalt-Plateaux of North-Western Europe." 2. Mr. Philip Lake, "The British Silurian Species of *Acidaspis*."

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Illustrated lecture, "Rambles in Epping Forest."

British Astronomical, University College, W.C., 5 p.m.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. James Mactear, "Mining and Metallurgy of Quicksilver in Mexico." 2. Mr. Henry F. Collins, "Quicksilver Mining in the district of Guadalcazar, State of San Luis Potosi, Mexico." 3. Mr. Thomas H. Leggett, "Notes on the Treatment of Tailings by the Cyanide Process at the Standard Consolidated Mines, Bodie, California." 4. Mr. Walter McDermott, "Notes on Deep Shaft Sinking in the Lake Superior Copper Mining District."

Microscopical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC. 19...Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. A. Rolfe, "A Revision of the Genus *Vanilla*." 2. Mr. E. S. Goodrich, "The Cephalopoda collected during the voyage of H.M.S. *Investigator*."

Chemical, Burlington-house, W., 8 p.m. 1. Discussion on the "Constitution of Terpenes and Camphor." 2. Miss Evans, "Derivatives of Dimethylaniline."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Donald Mackenzie, "Present Position of British Protectorates in East Africa."

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m.

FRIDAY, DEC. 20...Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

CORRECTION.—P. 31, col. 2, line 14 from bottom, *for* vapour *read* oil.

Journal of the Society of Arts.

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FRIDAY, DECEMBER 20, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 1 and 8, 1896, by Prof. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements, and Volcanoes."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue.

CANTOR LECTURES.

Mr. W. WORBY BEAUMONT delivered on Monday evening, 16th inst., the third and concluding lecture of his course on "Mechanical Road Carriages." On the motion of the CHAIRMAN, a vote of thanks to the lecturer for his valuable course of lectures was passed.

The first lecture will be printed in the next number of the *Journal*.

FOREIGN & COLONIAL SECTION.

Friday, May 17; C. WASHINGTON EVES, C.M.G., in the chair. The paper read was "Jamaica in the Past and Present." By Frank Cundall.

The paper and report of discussion will be printed in a future number of the *Journal*.

Proceedings of the Society.

TECHNICAL EDUCATION COMMITTEE.

The first meeting of the Committee appointed by the Council of the Society, in consequence of the resolution passed at the Conference held in June last, was held in the Society's Rooms, on Thursday, December 5th, at three p.m. Major-General Sir JOHN DONNELLY, K.C.B., Chairman of the Council, in the chair.

The following are the terms of the resolution:—"That, in the opinion of this meeting, it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by Technical Instruction Committees, but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that, with the object of giving effect to the same, this Conference recommends that a representative committee be appointed to draw up a report and prepare recommendations upon the whole subject."

There were present:—Captain W. de W. Abney, C.B., F.R.S.; Councillor P. Alden, West Ham County Borough Council; Arthur J. Baker, Leicestershire County Council; J. A. Bennion, Lancashire County Council; C. H. Bothamley, Somerset County Council; W. Bousfield, City and Guilds of London Institute; George Ledgard Bristow; Ernest Clarke, Royal Agricultural Society; W. R. E. Coles, Inverness County Council; F. N. Cook, Yorkshire (West Riding) County Council; F. W. Crook, Kent County Council; A. Dean, Hertfordshire County Council; W. Vibart Dixon, Yorkshire (West Riding) County Council; Dr. William Garnett, London County Council; Alfred E. Garrard, Science and Art Department; S. Maudson Grant, Lindsey (Lincolnshire) County Council; J. H. Hallett, Cardiff County Council; Percy Hawkridge, Derbyshire County Council; Alderman J. R. Heape, Rochdale County Borough Council; Alfred G. Henriques, East Sussex County Council; George N. Hooper, London Chamber of Commerce; Austin Keen, Cambridge County Council; Sir Charles Malcolm Kennedy, K.C.M.G., C.B.; Sir Stuart Knill, Bart.; H. Macan, Association of Directors and Organising Secretaries for Technical and

Secondary Education, also Surrey County Council; Sir Philip Magnus, City and Guilds of London Institute; J. A. Matthews, Gloucester County Borough Council; Frederick Oldman, National Association for the Promotion of Technical and Secondary Education; R. C. Palmer, City and Guilds of London Institute; R. H. Rew, Central Chamber of Agriculture; J. H. Reynolds, Manchester Borough County Council, also Union of Lancashire and Cheshire Institutes; Sir Owen Roberts, M.A., D.C.L., F.S.A., Treasurer of the Society; Sir Henry Roscoe, F.R.S., National Association for the Promotion of Technical and Secondary Education; Alderman Thomas Snape, Lancashire County Council; Rev. J. S. Warren, Lindsey (Lincolnshire) County Council; Frederick Wilkinson, Bolton County Borough Council; Sir Henry Trueman Wood, Secretary of the Society; Edwin Young, West Surrey County Council.

The CHAIRMAN, in opening the proceedings, read the resolution passed at the Conference in June, and said, with a view to giving effect thereto, the Society of Arts had sent out invitations very widely to all parts of the country, asking that delegates should be sent to the meeting. On the previous occasion a resolution or two were submitted with the view of eliciting the opinion of the meeting, but it had been thought more desirable on the present occasion that nothing formally of that kind should be laid on the table, but that the gentlemen present should be asked to give their views generally upon the subject. He had gone into this matter very fully at the opening meeting of the Society a fortnight ago, and he did not, therefore, propose to discuss it further. Speaking on behalf of the Council of the Society, he might say that what they really wished was to know the views of the country on this matter, and, more especially, whether there was such a general desire on the part of a considerable portion of those interested that the Society should extend its examinations, and endeavour to organise some General Examination Board as would justify the Council in taking further steps with thnse objects. He concluded by reading a letter received from Mr. Williams, secretary of the Northumberland Technical Education Committee, regretting his inability to be present, and saying that any conclusions arrived at with regard to the co-ordination of examinations would meet with hearty support and sympathy in that district.

Mr. W. BOUSFIELD (City and Guilds of London Institute) thought all would agree that there was one class of subjects of paramount importance in which examinations did not exist at the present time, viz., agriculture, and as he noticed there was a representative from the Royal Agricultural Society present he thought it would aid them very much if he, or someone representing the Government Department of Agriculture, would state how far they were prepared to go forward with examinations on subjects in which there were none at present. He thought the examinations of the City and Guilds Institute practically covered the great bulk of the examinations needed on questions of trades and handicrafts, but there remained the question of agriculture, and possibly the Royal Agricultural Society might be prepared to step in and fill the gap.

Mr. ERNEST CLARKE (Royal Agricultural Society) said his society had for the last twenty years carried on examinations very successfully, and they were much appreciated. He did not think there was any necessity for the Society of Arts or any other body to interfere with examinations in agriculture. What he conceived the Conference was met to-day for, was to try and co-ordinate the efforts made in different counties towards the teaching of agriculture. They had as many examinations in agriculture as were needed, but many people felt that a large proportion of these grants made to the county councils was, at any rate at the beginning, wasted, and if there could be any movement towards co-ordinating the different bodies with common objects, it would be very useful. If more examinations in agriculture were required, he believed the Royal Agricultural Society would be happy to supply the need.

The CHAIRMAN asked the extent of the examinations, and the number of those taking part.

Mr. CLARKE said there was a diploma in agriculture given to the best students. He had not brought a copy of the syllabus with him, but it was very elaborate, and went into every subject which anyone appointed to manage a large estate required to know. The numbers were not considerable, but the diploma was very highly appreciated, and was in this country the only thing which really corresponded to a diploma or degree in agriculture.

The CHAIRMAN said they all knew that the diploma of the Royal Agricultural Society was only given on a very complete examination, but, as he understood, comparatively few persons attained it. There were thousands of people being instructed in different parts of the country in the more elementary stages of agriculture, and the question was whether the Royal Agricultural Society or some other organisation could not be found, or whether it was desirable that it should be found, to provide examination and inspection for that more elementary kind of instruction. He then preceded to point out that there were, as he stated in his address, several subjects in which the Science and Art Department examined. Then came the technological subjects, in which the City and Guilds examined, and the commercial subjects, in which the Society of Arts examined; but there was besides a large class of manual instruction subjects, such as carpentry and those small handicrafts in which nobody, except in a kind of sporadic way, examined and inspected. The same might be said of domestic subjects, principally for women, such as domestic economy, cookery, and so on. Lastly, there were certain other subjects besides music, in which the Society of Arts examined, which it was difficult to classify, such as ambulance, fish culture, and things of that kind for which there was no examining body. There was thus a large field not covered by anybody at all.

Mr. CLARKE said the Royal Agricultural Society was in complete agreement with the phrase in the Chairman's address, in which he said :—" There is room for, and need for, some central organisation to which local authorities may appeal for assistance in examination and inspection and advice, when they wish for one or the other."

Mr. H. MACAN (Surrey County Council) thought there was some little danger of the Conference getting off the track. Mr. Clarke referred to the necessity for some central body giving advice and distributing information, but that was scarcely a matter for the Conference to deal with, more especially when they recollected the magnificent services rendered in that direction by the organisation which had its head-quarters at Dean's-yard. He apprehended it was not the intention of the Society of Arts to endeavour to set up any rival organisation, and if it were it certainly would not be countenanced by the county councils, which owed such a deep debt of gratitude to that organisation, more particularly to the Duke of Devonshire, Sir Henry Roscoe, Mr. Arthur Acland, and others, who had worked on it.

The CHAIRMAN said of course there was not the faintest wish or intention to supersede or interfere in any way with that organisation, but, as he had pointed out before, that society did not either examine or inspect. He might say on behalf of the Society of Arts that, if it would take up this movement, the Society would hand it over very gladly.

Mr. MACAN said he was glad the Chairman had made it perfectly plain that it was not his desire to in any way overlap the work of that society. The examinations of the Royal Agricultural Society were of a very high class, but practically they were limited to a few of the best agricultural students in the kingdom. Mr. Bousfield, he took it, was referring to a somewhat lower stage of examination, more general, and adapted more to the needs of the respective localities, and it must be recognised that for such purposes an examination suitable for one part of the kingdom would not be suitable for another, because the conditions were so diverse. He did not believe that any general system could properly cope with the conditions of agricultural examination in the country. This subject was certainly one which they must hope that the various University colleges, who were doing such admirable work in connection with agriculture, and particularly in the North, would be induced to take up and to develop local agricultural examinations of a lower grade than those of the Royal Agricultural Society, applicable to the needs of the respective localities. There were many subjects mentioned in the lists drawn up for the purposes of the Conference which came in the same category, particularly subjects like mining, in which the conditions were very diverse, and must be taken up by local bodies. He would also remark that very excellent work had been done within the last few years by the Royal Horticultural Society in formulating a scheme of examinations which were applicable to practical gardeners, and which had been largely utilised in Surrey and Kent. Again, very excellent examinations in domestic subjects, health, science, and elementary ambulance work and cookery had been undertaken in his county, and in some others by the National Health Society during the last three or four years. With regard to the general principle, elementary examinations in a great many of these subjects were very well conducted by certain associations and institutes in the North and the Midlands. In the South they had not the same advantages, and there there was a magnificent field for the energies of the Society of Arts. Then there was a large field of more or less elementary work in various technological, commercial, and other subjects below the level of the City and Guilds Institute, in which examinations were very much needed. In the South-east and South-west there were a large number of students passing out from continuation schools into technical classes for whom there was no proper system of examinations. If a small executive committee could meet in conference with the committee appointed by the Chamber of Commerce, and decide upon some general rational system of commercial education adopted to London and large towns, it would be conferring a great benefit on the community.

Mr. A. G. HENRIQUES (East Sussex County Council) said he feared the majority present were hardly aware of the tentative character of the agricultural education which was being attempted to be carried out in the agricultural counties. They did not even know what were the proper subjects to teach, much less how to examine the students. The whole system of agricultural teaching in the Midland counties was of very recent origin, and they had not data enough to go upon. There were two forms of examination, the examination on entering an agricultural college, and an examination on leaving it. With regard to the former, it was a painful thing to refer to, but the examiners were chiefly struck with the crass ignorance of those who submitted themselves in order to get a scholarship to keep them at college. He had had the honour to be associated with others in superintending the examinations for the scholarships given by the County Council, to be held at their Agricultural College at Uffington, and he could say from unhappy experience that the students who had been at elementary schools up to 14 or 16 had forgotten a great deal that they had learnt, and the difficulty was to tone down the examinations to such an extent that they would be able to get sufficient students to enter the Agricultural College. One could not speak of agricultural knowledge, there was no knowledge of anything—hardly the elements of knowledge. The existence of a great body like the Society of Arts, or any other institution, leading the way to secondary education was quite out of the question. What the County Councils required with regard to the first examinations was an absolutely free hand. They wanted now to evoke a desire to obtain agricultural knowledge, and were obliged to open the doors as widely as possible to students of the humbler rank, so that they might, through the college, obtain that agricultural knowledge which, not only their county, but the whole country required. With regard to the examinations on leaving the college, he could say with certainty it was too early yet to say anything. If such a meeting were held in three or four years they would be in a much better position to give an opinion, but in the meantime, until they had accumulated vastly more information, and had obtained the necessary data upon which to establish a general system, he hoped the counties would have a free hand left to them to do the best they could. He quite agreed with Mr. Clarke that a day might come when a strong body might co-ordinate in establishing a uniform system of education, but they must first learn what the agricultural population of the present day was capable of receiving, and must teach that as well as they could. Then, in a few years, they might be able to decide on some system of co-ordination which might be of inestimable service.

Sir PHILIP MAGNUS (City and Guilds Institute) said the view enunciated by the last speaker was perhaps one of the strongest reasons which could be adduced for the establishment of one or more central bodies to advise with respect to agricultural education. He did not think there was any function which examination served which was more useful than that of indicating the kind of instruction which should be given. The greatest service which the City and Guilds Institute had rendered to the country with respect to technical education was indicating to the various centres what instruction should be given. For that reason it might be serviceable if some central body were established which, even at present with the expert advice they would be able to obtain, might advise County Councils on these matters. He was by no means certain that one central organisation would be the best, and was inclined to agree with Mr. Macan that on the whole it would be better to leave the matter in the first instance to the University colleges, which would form centres of higher education for the whole country; but that advice coming from central bodies capable of appreciating the various conditions would be valuable, he had no doubt. It was rather difficult in a meeting of that kind for an official to give information with respect to what was being done, but, for the information of those present, he might say that the City and Guilds Institute was fully aware of the necessity for more technological instruction than that required in preparation for its existing examinations, and that for some time past the matter had been under the careful consideration of its committees, and reports were now being drafted with the view of establishing preliminary examinations adapted to apprentices, which should lead up to more specialised instruction necessary to be given in order that the candidate might pass an examination in the ordinary and honors grade.

Sir HENRY ROSCOE, F.R.S. (National Association for the Promotion of Technical Education) said the Association which he represented would welcome any suggestions which could be made with regard to improving the present condition of examinations, as well as of the system of teaching in those various subjects throughout the country. It would be well to distinguish between the two distinct aims which had been placed before them—one, the increase of examinations, or, rather, the desirability or otherwise of fresh examinations being introduced; and, secondly, that for co-ordinating the systems of examinations throughout the country. With regard to the first, he felt strongly that they had enough already, that the number of distinct bodies and boards examining was rather larger than desirable, and that to propose a new body for this purpose was objectionable. At the same time, there was no doubt that for many subjects on the list there were no examinations, but he was not aware that the institute represented by Sir Philip Magnus was unable or unwilling to undertake any of the subjects on the list, provided they were such as could fairly be examined in (because there might be some which did not lend themselves to written examinations), and, in the second place, that there was a sufficient demand for such examinations. With regard to the general subject, he thought they ought to take care to recognise not only in agriculture, but in many other subjects, that local people were better judges of what they wanted than any central authority, and whilst they wished to co-ordinate and systematise them—and this was a matter of the very greatest importance—they ought to leave a free scope to local authorities to carry on their examinations in the way they knew best. The Association he represented would be willing to co-operate in assisting to co-ordinate the examinations throughout the country, but, for his own part, he did not feel it was desirable that new Examining Boards should be instituted.

The CHAIRMAN said what he understood by co-ordination was this: there were various Boards which would examine, but if a County Council wanted to have examinations in technological subjects, they had to go to one person, and to go through certain forms; then, if they wanted to be examined in commercial subjects they had to come to the Society of Arts, form a committee, and so on, according to the Society of Arts' rules. Then the Royal Agricultural Society had its own set of rules, and so had the other bodies which were examining in domestic economy. His own idea of co-ordination was that these several bodies should, if possible, form some kind of central office to which the County Council might apply, saying we want examinations or we want inspection—which was quite as important, or even more so—in certain subjects, and that one letter and one form should serve for the whole thing instead of having to go to these various bodies one after the other. But this one central office should arrange without interfering with the several examining bodies for their several examinations. But, after all, inspection was the matter of greatest importance. A County Council might say we have had classes in such and such a subject, and we want to know whether they have been carried on in the proper way, will you send us someone who can give an opinion? It was not proposed to interfere in the slightest degree with the absolute control of the separate local authorities.

Sir HENRY ROSCOE said the subject of inspection had not been referred to before, but it was a very serious matter. How far it would be possible for any general Association to begin or set on foot such a system was a question he was not prepared to give an opinion upon, but it seemed to him that was a matter which would come under a Government Department, and if to be done on a scale which was no doubt necessary and extremely important with regard to all technogical subjects, it must not be done by private enterprise but taken up by the State.

Mr. J. H. REYNOLDS (Manchester Borough County Council) said he appeared in two capacities, representing the Manchester Borough County Council and also the Union of Lancashire and Cheshire Institutes. He wished to speak chiefly of the latter, because it seemed to him to typify exactly the kind of Union that should exist in every part of the country where possible. This Union had been in existence for 50 years. Last year some 27,000 papers were worked by students enrolled in the 230 institutes comprised within the district. The special object of the Union was not to examine in advanced subjects so much as in the great mass of elementary subjects which no central body could habitually reach. This left an open field for bodies like the Society of Arts, the Science and Art Department, and the City and Guilds Institute, to whom they looked for the advanced examinations, the certificates in which would carry some weight as being gained in competition with all the other advanced students in the United Kingdom. What ought to be done was to encourage the formation of these Unions. The Lancashire and Cheshire Union refused to go beyond its own borders, and, in consequence, a Midland Union was being formed, which, he believed, would be a strong one, being largely formed by the University College, Nottingham, and the Masons' College, Birmingham. If there was one note which sounded through the report of the Royal Commission, it was that of the desirability of decentralisation. They suffered too much now from examinations which from the necessity of the case regarded the country at large rather than the special needs of particular districts, and he might even venture to suggest that the City and Guilds Institute found it most difficult to meet the varying needs of different industrial localities. Still that Institute left merely elementary examinations very largely to local bodies. He thought they suffered from too much specialisation, and were not paying sufficient regard to general education, the result being seen in all large institutions where the great bulk of the students were utterly unfit by their insufficient general education to take advantage of true technical instruction. Evening continuation schools ought to be encouraged, and after them should come central schools for special technological instruction. Not until then could any effective work be done. He had read Sir John Donnelly's admirable address at the opening of the Session, and he must be pardoned for looking upon it as a manifestation on the part of the Society of Arts. Revising the whole field of education which had been created by the Technical Instruction Act, he ended by asking the question what were the means for obtaining an audit of the results, and then went on to say that there should be some central organisation. Now he for one could not see the wisdom of a central organisation; he thought it was better that the work should be largely divided. Although he knew nothing of agriculture, and did not believe they could grow a blade of grass in Manchester, he thought the proper body to take that in hand was the Royal Agricultural Society and its affiliated branches, if there were any, and the University colleges which dealt with such subjects. They could deal with the matter much better than an organisation drawn together in London. Again it would be nonsense to displace the City and Guilds Institute, and to attempt to interfere with the organisation it had built up. What he thought the Society itself could do was to increase the number and improve the quality of commercial examinations. It did not matter if only a small number took advantage of them. The local unions would do their share towards preparing the elementary students, but for advanced students they wanted a central body, and the Society of Arts was doing its proper work in making that branch of the subject as thoroughly effective as possible. As for a central body to give advice, they had already five or six existing, the Science and Art Department, the City and Guilds Institute, the Society of Arts, the Association for the Promotion of Technical Education, and the Association of Organising Secretaries. They were smothered under Associations, and to create another, or to attempt to bring all these varied bodies into harmony, seemed to him an impossible task, and in any case an undesirable one. He could not conceive how a huge Government Department could bring itself into relation with voluntary bodies; yet it was from these voluntary bodies that some of them had been able to get the most valuable information in the prosecution of their work. He felt strongly that there was not time to go into committee to draw up a report, and say what particular subjects of examination should be included or not in a given scheme. They had bodies which could take up these examinations, and if there were a subject which properly belonged to one rather than to another the others would let it alone.

The **Chairman**, in order to put himself right with the meeting, said he certainly spoke of an audit, and said an audit would be called for, for he did not think the country would go on spending £750,000 without knowing what good was being done. But he never suggested any central body, still less a Government Department, as the auditor. All he suggested was that there ought to be some means for letting the country know how well or how badly the money was being spent, and he felt that more strongly because he saw, every now and then, that men of position were stating that the money given for technical instruction was being to a great extent wasted; he did not think so himself, but one would like to have some evidence that it was not.

Mr. G. N. **Hooper** (London Chamber of Commerce) said he had hoped his chief, Sir Albert Rollit, would have been present, but, in his absence, he might say they were not desirous in the London Chamber of increasing the large number of these examinations. Two or three weeks ago they had a representative meeting of university and examining bodies, in order to ascertain whether it would be possible to reduce the large number which at present existed. They were most anxious to carry out what had been suggested—a better development of higher commercial education. The syllabuses for the junior and senior examinations were now complete, and as they could not get exactly the building they desired they were converting the Council-room into a college for the purpose of carrying on four courses of lectures on commercial subjects, viz., commercial history, geography, law, and lastly banking and finance. They fancied the time had come when it would be an immense advantage to the employers of labour to have a higher education so that they should be in a better position than those whom they employed, and who were at present reaping the benefit of technical education. Another subject of great importance at the present time was higher technical education. Very little provision was made for teaching the young men who were to be the employers of the future. The young merchants, bankers, or manufacturers must at the present either attend the night classes intended for their young men or go without, or go abroad. In his own case he had to send three young men to Paris, and that was an illustration of what constantly happened. Those who wanted to get higher technical education had to go abroad, but that was not the state of things they should rest under.

Mr. R. H. **Rew** (Central Chamber of Agriculture) was glad to say he was very much in harmony with the remark of the gentleman from Manchester, viz., that they were not anxious to establish any further organisation for teaching agriculture. He should also like to say that from the farmer's point of view he had agreed very much with what fell from Mr. Henriques that the difficulty was not to get students examined, but to get students at all. The hesitation of farmers was greatly due to the fact that they had not in all cases that confidence which no doubt if they were wiser they would have in the scheme of education put before them. He was not defending that attitude, but it must be recognised. It would be less in harmony with their ideas, if any examining body were set up of which they knew nothing previously, and in which they had not confidence. Mr. Clarke had said that the Royal Agricultural Society, which had already provided excellent examinations, as far as they went, were prepared to go farther. He admitted that they did not examine and inspect in those particular subjects which were taught under the Technical Instruction Committees. They did not send out inspectors or hold local examinations, but he gave a sort of hint that they might be disposed to do something further in that direction. He would also point out that the Board of Agriculture at present aimed at some kind of inspection, for the purpose of seeing that the money entrusted to it—about £60,000—for instruction in dairying and other matters was properly spent. In either of those two directions—either under the sanction of the Royal Agricultural Society or of the Board of Agriculture—would be the best hope of getting a system of examination and inspection in which the farmer would have confidence.

Mr. R. C. **Palmer** (City and Guilds Institute) thought it was not so much co-ordination as regulation and control that seemed to be most wanted. It was always found that elementary education required to be controlled by the representatives of secondary education above it; in fact, it was that very necessity of dividing elementary from higher education which had brought about the late report on secondary education, but that, of course, required to have regard to local needs; and the idea of bringing about large conjoint Boards, to advise on all sorts of subjects, seemed to him to offend against that cardinal principle. You could not have a better example than the subject of agriculture. The University of Cambridge was the first to throw open its instruction in science on matters pertaining to agriculture to farmers, and this had been largely taken advantage of. In that way he thought the University colleges in Leeds and Manchester in the North, and perhaps in London, might be enabled with the help of the Royal Agricultural Society to do a great deal. Mr. Clarke had omitted to say that the Royal Agricultural Society supplied a great motive for their examination inasmuch as they offered several substantial scholarships to successful students. Even in France, where everything was centralised, the Government had been obliged to establish five normal schools of agriculture owing to the different practices in five different parts of that country. He did not want to boast, but the reason more subjects were not examined in was not any difficulty on the part of the Director of Technology. The difficulty was to restrain him. What was most wanted was that which was so well done by the Society of Arts in dealing with commercial subjects, and he believed that voluntary action by societies which were trusted by County Councils would do all that was necessary.

The CHAIRMAN suggested that it would be no more centralisation if the two societies specially referred to were to work together instead of working separately.

Mr. BOUSFIELD thought the result of the discussion was to show a feeling that the respective bodies providing examinations should develop their own work as far as possible, and that any amalgamation which might be subsequently found necessary should rather arise within themselves than be forced upon them from outside. He felt strongly that the City and Guilds Institute, for instance, was capable of developing its examinations as might be required by the wants of the community, and might be trusted to go into the various fields of work which time might show to be necessary. He might mention one fact that happened during the last three months. The institute had taken over the examinations in needlework, or was about to do so, which had been until lately managed by the Association for promoting improvement in plain needlework. The same kind of thing ould probably happen in future. The smaller examining bodies would merge in the larger bodies, and that would be a purely natural process. On the other hand, there were a number of subjects mentioned in the list which seemed to him not to lend themselves to any examination at all, such as bent ironwork and those similar kinds of work which were taken up in some parts of the country, such as wood-carving. It was impossible to have any kind of central examination for subjects of that kind. It might be dealt with by some kind of local certificate, but it would be giving it altogether too important a position if the students were examined by some central organisation in London which would grant a certificate, and make these evening students, who really did work which was of very little value, think that they had merited a very great deal from their country. These questions must be dealt with locally. He had perfect confidence in the County Councils, acting under the advice of such men as Mr. Macan, dealing with questions of that kind, but the higher examinations must have some central organisation to control them, and give certificates. He thought that meeting would not be thrown away if it only threw on the Royal Agricultural Society the responsibility of looking into this matter rather more carefully than it seemed to have done in the past, and, if necessary, providing examinations, not only of the highest class, but such as would deal with the real wants felt by the Technical Instruction Committees in the various counties.

Mr. W. V. DIXON (Yorkshire County Council) said two distinct questions had been raised—one whether there should be some sort of co-ordination such as had been suggested, or whether there should be a greater expansion of the different bodies now carrying on the work. It seemed that, unknown to each other, various bodies had been actually meeting and discussing and drawing out programmes which probably to some extent would overlap, and he was bound to say he thought it would be a good thing if these bodies, such as the City and Guilds Institute, should at all events meet and discuss the matter in conjunction with the Society of Arts. Reference had been chiefly made to individual subjects which were not examined in, but the question had also been mooted whether there might not be a general examination such as would be expected to be passed by any person who had had a reasonably-good commercial education in a secondary school, which might serve to take the place of the preliminary examination on entering the professions, and so forth. That might be dealt with in the general consideration of examinations. The question was whether anything at all was to be done as the outcome of that meeting, except by the various bodies represented to take a note of the points brought forward, or whether it was of a sufficiently representative character to initiate the appointment of what might be called a consultative committee, which would be made as representative as possible. If such a committee were formed, it should clearly include the representatives of the various bodies who had spoken that day, the Society of Arts, the Chamber of Commerce, County Councils and boroughs, and Mr. Macan also mentioned the Horticultural Society and the National Health Society, and probably they would find there were some others giving certificates or holding examinations which none of them knew anything about. If they could all meet and map out something like a scheme of work which they could carry on either individually or by means of sub-committees, they would get rid of some waste power which now existed, and people in the country would know where to come for any particular examination. If he were in order, he would move "That a committee of the character he suggested should be formed to consider how examinations applicable to technical and secondary education may best be provided for, and that the following and other bodies be invited to send representatives."

Captain **W. de W. Abney**, C.B., F.R.S., said it seemed to him that the Committee had resolved itself into a Conference, for they had heard all the same arguments at the Conference in June. When a deliberate vote was taken, and a resolution passed appointing a committee to decide how to carry the thing out, they ought not to consider whether it was to be carried out. He did not see any use in debating the matter over and over again. No doubt the objections put forward were perfectly valid to the objectors, but, at the same time, at the Conference it was distinctly stated that the committee was to be formed. Now they were in committee, and ought not to be debating the first principles on which the committee was called. He should, therefore, support the resolution submitted by Mr. Dixon for constituting a sub-committee.

Sir **Charles Kennedy**, K.C.M.G., C.B., said that he had brought the question under discussion before the Exeter Chamber of Commerce, at their annual meeting, held on the 25th ultimo. That Chamber appreciates all endeavours to promote commercial and technical education properly conducted, and also desires to remedy any existing defects arising from confusion in methods of teaching, the overlapping of functions of different organisations, and consequent waste of force, time, and money. The action of the Society of Arts in these matters meets with sympathy and support; and the value attached to their examinations is proved by the number of the students who enter for them. Greater confidence is felt in an established and recognised system of testing the results of study than in new and untried schemes. He hoped the Society of Arts would not lessen their programme of examinations, but would rather add to it, and improve it, as may from time to time be found expedient. He thanked Sir John Donnelly for his action in the matter, and cordially supported the proposal for the appointment of a small representative committee to examine into and report upon the whole subject. The proposal to this effect, submitted to the present meeting, did not interfere with schemes now in operation; he did not see any reasonable objection to it; and its adoption would afford further and more mature consideration of questions of much interest and practical importance to the whole community.

Mr. **Bennion** (Lancashire County Council) supported the resolution to appoint a sub-committee. Experience in Lancashire showed they did require a strong central body for examination in subjects such as had been mentioned, particularly in connection with elementary classes in agricultural, commercial, and domestic subjects. It seemed to him the only way in which any good could be done was by referring the matter to a small sub-committee; and he would suggest that the committee be selected from that meeting, which would save time.

Mr. C. H. **Bothamley** (Somerset County Council) said he should not oppose the resolution, but he had some doubt whether any good would come of it. He thought the general feeling of the meeting was that which he certainly shared, that at present the field was pretty well covered by the three bodies to which reference had so often been made, and that there was very little overlapping. There was a distinction between the kinds of examination taken up by the Science and Art Department, the City and Guilds Institute, and the Society of Arts, and he doubted very much whether anything in the nature of a central office would be practicable. He would suggest, in order to simplify the matter, that each of those three bodies should agree to recognise the same local committee for examination purposes, and that each should as far as possible have the same local rules for examinations. If that were done the mere fact of having to write to three separate offices for three kinds of examination would be no great difficulty in practice. With regard to general examinations in elementary subjects he agreed with Mr. Reynolds, and some other speakers, that it was not desirable that central bodies should concern themselves with them; they could be undertaken by local authorities such as the Unions of Institutes in the Northern and Midland counties. In the Southern and Western counties, where communication is more difficult, and the population thinner, the difficulty of organising such institutions would be greater, but he believed it could be done. The function of central bodies, such as the Society of Arts, he took to be to provide the higher class of examination certificates which gave a certain guarantee that people who applied to be appointed as teachers had a certain minimum amount of knowledge, and such certificates were very useful to county councils and committees.

Mr. P. **Alden** (West Ham Borough County Council) agreed with the suggestion that the three societies should recognise one local committee, and they might possibly go a step further, and by means of some committee which could easily be formed, assimilate and clarify the information which all the societies had at their disposal. One of the difficulties, especially in the provinces, was to obtain information in an easy form.

Alderman T. SNAPE (Lancashire County Council) suggested that since the Conference was held and the committee appointed, the whole aspect of the question had been changed by the publication of the report of the Royal Commission on secondary education. The very prominent feature in that report was a reference to the importance of examinations, and it was quite possible that on the recommendations of that report, some Government Bill might be introduced in the coming Session. Perhaps he was too sanguine, but he trusted it might be, and he knew from Sir John Gorst's own assurance that he was very desirous of bringing in a Bill. Now if legislation took place there would unquestionably be in the Bill some provision made for examinations, perhaps to take in hand the whole of the subjects they were now discussing. He was disposed to support Mr. Dixon's proposal if he would alter his description of the committee from consultative committee to a sub-committee to report upon the different methods of examination which now prevailed, and after giving a condensed epitome of those methods if they could in a small space append to it some recommendations of their own with a view to prevent overlapping and making examinations uniform it would be useful. The difficulty he had experienced was that these examinations were not uniform. As to the certificates given at the prize distribution in various parts of Lancashire, both those who received them and the public were often in ignorance as to their value, whereas they should possess more or less the same value. A report of this kind by a sub-committee might be of assistance to legislators when the Bill came before them for consideration, but certainly the committee should not be a large one.

Mr. ERNEST CLARKE said the Committee was placed in some little difficulty inasmuch as there was no report which they could discuss. In his preliminary remarks the Chairman said he was rather anxious to hear what the meeting had to say. Now that he had heard what they had to say would he kindly draft a report, meanwhile adjourning the committee *sine die*, and call them together again? Even a sub-committee, unless a very strong one, could not be held to include all interests.

The Rev. J. S. WARREN, Lindsey (Lincolnshire) County Council) said if anything were done by the sub-committee, he hoped some aid would be given to the agricultural counties. He had come there hoping to gain some wisdom and knowledge which he might carry back to Lincolnshire, but he was sorry to say he had not gained much. In that county they wanted the elements of knowledge, and if the Society of Arts could inform them how best to spend the large amount of money which had been allotted to them in acquiring knowledge, they would be very glad. They were not at all in a position to be examined about anything, because they knew nothing to be examined about, but they were anxious to gain knowledge and to be instructed.

The CHAIRMAN said he did not know why the committee should restrict itself so much to the subject of examinations. He had endeavoured to point out that what they were trying for was not examination alone, but inspection and advice; and if anybody would do him the honour of reading his address, he would find that he put them quite as prominently forward as the question of examination—that County Councils might have somebody to whom they might refer for advice and assistance in inspection.

Mr. MACAN suggested that Mr. Dixon should not press his motion, and said if Mr. Clarke would put his suggestion in the form of a proposition he would second it, viz., "That the committee should adjourn."

After some further discussion,

Mr. CLARKE said he would move an amendment in that form.

The CHAIRMAN then read the resolution proposed by Mr. Dixon, and the amendment: "That the Committee now adjourn." On putting the latter to the vote, he declared it carried.

Mr. BOUSFIELD then proposed a vote of thanks to the Chairman, which was carried unanimously, and the proceedings terminated.

FIFTH ORDINARY MEETING.

Wednesday, December 18, 1895; WILLIAM CHARLES KNIGHT CLOWES, M.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Britton, Percy Wilson, 30, St. Mary's-road, Peckham, S.E.
Bush, George, 34, Cleveland-square, W.
Devonshire, James, British Thomson-Houston, Ltd., 38, Parliament-street, S.W.
Lock, William Henry, 6, Serjeant's-inn, Fleet-street, E.C.
Parshall, G. F., British Thomson-Houston, Ltd., 38, Parliament-street, S.W.
Pink, Thomas, Thornton-house, Thornton-road, Clapham-park, S.W.
Simms, Frederick R., 95, Billiter-buildings, 49, Leadenhall-street, E.C.
Taw Sein Ko, Secretariat, Rangoon, Burmah.

The following candidates were balloted for, and duly elected members of the Society :—

Martin, Stephen Luther, 20, Thurloe-place, S.W.
Ogilvy, Colonel William Lewis Kinloch, C.B., Itchen Abbas, Alresford.
Pritchard, Prof. William, M.R.C.V.S., 5, Regent's-park-road, Gloucester-gate, N.W.
Stones, James Herbert, 10, Richmond-terrace, Blackburn.
Tavaria, H. K., B.Sc., Victoria Technical Institute, Parei, Bombay.

The CHAIRMAN, in introducing Mr. Southward, said this subject had lately been attracting considerable attention in the minds of all who took an interest in the working of processes by which printed matter was produced. These processes were mainly two; first, that of picking up and setting types in lines; secondly, the conveying the impression of those types to paper. With regard to the second process there had been great changes in the mode of working; with regard to the first there had been few. With the second process the first important change was about 100 years ago, when Lord Stanhope invented a hand-press which superseded the old wooden screw-press. This hand-press was worked by a knuckle-joint action with a lever handle, and when worked by capable hands produced about 500 copies an hour of small sheets. Then came the great revolution in this second process, the use of steam for working printing machines. Those machines had two cylinders over which the paper passed, with a moveable table underneath on which was placed the type. Various improvements had been made in these machines, and towards the middle of this century the rotary machine, which had been invented some time before, was brought more or less into use. The result of these machines had been that, where 100 years ago by manual labour 500 sheets per hour of a size of about two feet by one and a half were produced, they now produced from fifteen to twenty thousand sheets per hour of about four times the size. But with regard to the first process, that of setting type in lines, there had been very little change in the original method. Probably if they could go back more than 450 years they would find that Gutenberg was picking up and distributing type in very much the same way as it was generally done now. He said generally because about the same time as the rotary machine was introduced the first practical method of mechanical composing and distributing type was introduced. Since that time considerable improvements had been made. Many machines had been introduced, and a new method had been very much used in America, and was now being used in England, whereby, instead of casting moveable types, bars of type were cast. This was the process which Mr. Southward was going to describe.

The paper read was—

MACHINES FOR COMPOSING LETTERPRESS PRINTING SURFACES.

By JOHN SOUTHWARD.

The subject of Machines for Composing Letterpress Printing Surfaces is a wide and a comprehensive one. If time permitted, I should like, in the first place, to refer to the History of inventions of this kind. Such a review would begin with the first patent granted for a composing machine in 1822, and for a distributing machine in 1840. It is a remarkable fact that the specifications of these two inventions foreshadow, as it were, the principles of all the composing machines that have since been constructed. As far back as 1842, a popular periodical was actually set up by machine. Up to the year 1860, about 30 machines and modifications of machines were patented. Many machines were made according to these specifications, and were tested in printing offices. They embodied every important principle to be found in the machines that have succeeded them. I fix the date 1860 because I do not find that after that any really new ideas have been enunciated. Indeed, inventors have ever since brought out machines which have been little more than variations or developments of the designs of their predecessors.

I should like, in the second place, to deal with some of the Mechanical Principles of composing machines. Hundreds of patents have been taken out during the last seventy years, but they may all be divided into well-defined groups. There are first of all, those in which ordinary types are used. Inventors have devised expedients for increasing the speed of hand composition from the usual cases of the hand compositor. They have suggested specially-contrived cases. Others have brought forward inventions for dispensing with cases and providing machines which do nearly the whole of the mechanical part of the compositors' work. Others have gone much further than this, with proposals to do away altogether with moveable types, and to produce plates directly, by casting either from punctured or stamped matrices, or from moveable and interchangeable metal matrices.

Briefly, the two systems now adopted may be differentiated as type-setting and matrix-setting machines. As I shall be able to touch only the mere fringe of my subject I must confine myself to an examination of the general features of these two systems. Even these, however, involve many more considerations than could be adequately dealt with this evening, and a further limitation will be necessary. Hence, I shall not attempt more than an inquiry into the economic results of the two systems, and an answer to the question which of them produces letterpress printing surfaces with the greater cheapness. This may seem a somewhat ignoble narrowing down of such a subject, but it is, in reality, the aspect of it which is of greatest present importance and of greatest general interest.

Accordingly, I intend to avoid entering into mechanical details, except when they appear to be necessary to illustrate the points I propose to submit to you. My very cursory examination will not involve a criticism of the merits or demerits of any particular machine. I shall merely contrast the principles of the two main classes of machines with a view, as I have said, to estimate their respective economic advantages.

As probably everyone present is aware, an original letterpress surface, to print alphabetical characters and punctuational marks, one that produces the plain reading matter, or text, of books and newspapers, is formed, according to the ordinary method of typography, by combining together, or composing, one by one by hand, moveable interchangeable types.

The compositor has these types assorted into little heaps each contained in one of the compartments of his case. According to the wording of the copy he is engaged upon he first "sights" the type he requires. He picks it up with his thumb and fingers, and conveys it to the tool called a composing stick, which he holds in his left hand. Letter after letter is set up in the same way. Composing consists not merely of thus assembling the types together, and of putting the proper space between the words, but it includes spreading them out by additional spaces, may be, and making the line of the exact stipulated length. This is called "justifying."

The work of the compositor is, obviously, partly mental, and partly mechanical. He has to decipher his copy, to spell the words of which it consists, to judge whether he shall use a capital letter or a small letter, and to punctuate the words. This is the mental part of his work; it cannot be facilitated by machinery. The lifting of the several types and the arranging of them in the stick is mechanical work. It would seem that it might well be done by some kind of mechanism. To provide mechanism for the purpose has been the aim of successive inventors of type-composing machines.

At first sight, the designing of a machine for assembling types together and arranging them in orderly manner in lines, might not seem to be a task requiring great ingenuity and skill. The difficulties are not apparent until the nature of the problem is somewhat closely considered. Let me point out some of those difficulties.

There is, first of all, the difficulty of operating on such small objects as printing types. Take for instance the letter l in nonpareil. From one end to the other—its height to paper—it is only about $\frac{7}{8}$ths of an inch. Its body is $\frac{1}{12}$th of an inch. Its thickness or width is $\frac{1}{35}$th of an inch. Some of the types are much smaller; their thickness is little more than that of an ordinary visiting card. Such objects are of course very light. Of the little pieces of metal which print the l, 1,760 weigh only one pound. Such objects are not only small and light, but fragile. They require the most delicate treatment. A very slight strain upon them in one direction will break them. Add to this that they are extremely delicate. The hair lines of their faces would be destroyed by slight friction frequently repeated, and the type would be rendered useless for printing purposes. To deal satisfactorily with objects of this character, a machine must have very delicate parts; and delicate machines are ill-adapted to the conditions of the printing office.

This is the smallest of the difficulties involved. The types are not only small, but they are of various sizes as regards their width. The machine must provide for the thick m, and the thin full point. Few people realise how much types vary in thickness. It is not generally known that amongst the 244 sorts which comprise some founts of roman and italic, there are 190 different widths. It might be easy to set a machine to pick up any one width for a time, and then to set it for another width. But these widths happen, as it were, promiscuously. In the word "width" there are letters of four different dimensions, and the next word that may present itself will comprise a different order of letters. To meet this difficulty, much complexity is rendered necessary.

There is a still greater initial difficulty. It would be much easier to make an apparatus for dealing with such objects, however small, light, delicate, and variously sized, than one which will provide for every combination of letters to be found in the copy to be set up. The hand compositor, as I have mentioned, has types arranged in separate compartments of his case. The instant he sees a certain letter is wanted, he throws out his hand to the particular box in which it is contained, and picks it up. A pair of cases—that is, for an assortment of one face of letter—measures about 2½ feet one way, and 2 ft. 9 in. the other way. The types are assorted into about 150 boxes. The intelligence and dexterity of the compositor enable him to extract the different types with a certain degree of rapidity and accuracy. To do this by machinery is quite another matter. It cannot possibly be done altogether by mechanism. The selection of the types must be done by the brain of the compositor. What the inventor has to do is to enable us, by mechanism, to assemble together any possible combinations of letters found in the words of the copy. This is quite another thing to providing for any one letter, however small, being brought instantly out of its receptacle.

Now, no machine could pick the letters out of an ordinary case and form them into lines of reading matter. The reason is, that they lie in these boxes higgledy-piggledy. The compositor has not only to sight the right type, but he has to put it in the right position in his stick. Accordingly, the types must be arranged in order, the faces all one way, and the nicks all one way. This is the first requirement. The next is that, however the types are located, each one must be accurately brought, as required, to one place—the place corresponding to the composing stick of the hand compositor. This requirement involves the provision of channels, along which the types can be brought to their destination. It also involves means for pushing, or impelling, the types along those channels.

Nearly all inventors of type-setting machines, from the very first, have met this requirement in one way. They have had the types set up in rows, one sort in one row. These rows have been laid side by side, in grooves or tubes. The outlets of these tubes are ranged in a line. Mechanism is provided whereby the first letter in any one of the groups or tubes, or what not, shall be extracted on a key being depressed by the finger of the operator. When he strikes the key a letter in the groove is drawn or falls out. But when it drops out it has to be conveyed to the composing stick. It is led through channels. These channels begin at the mouths of the several tubes. It is necessary that the grooves all converge to a single point, over what I have termed the composing stick. The channels usually consist of grooves cut into a metal plate. This is called a guide-plate.

This device is open to many objections, and, indeed, forms the weak part of nearly every machine in which it is adopted. I will mention a few of its drawbacks.

The converging grooves usually have to be adapted for types of different thicknesses being brought down one channel. These arrangements often consist of delicate springs, which, with rough handling of any kind, will get out of order. They are very susceptible to wear, and very liable to disarrangement. There are difficulties arising from the various weights of the letters, and their tendency to fall with unequal velocity. Sometimes they strike the recceiver with great force and rebound; sometimes they turn round unexpectedly in their channels; sometimes they stick fast, and have to be released with a bodkin.

The dust and solid particles which often adhere to the grooves, as well as to the types, render their delivery uncertain. Hence the most perfect cleanliness of the guide-plate and of the type is essential. Much time is required to properly clean the guide-plate, and in the printing office unclean and "sticky" type cannot always be avoided.

In working type that is not entirely clean, the dirt is left on the plate in specks and little heaps. These cause obstructions, and the letters are turned in their course. The objection is of more importance than might at first sight be imagined. It is not felt so much on dry as on damp days. It has been said that type-setting machines work better in some parts of America than in England, because the atmosphers is drier. Possibly there is some truth in this. At any rate, the difficulty arising from such a small cause as insufficiently cleansed type, and a damp guide-plate, illustrates the extreme delicacy of such machines, which is one of the chief drawbacks in them.

Again, the types are not always delivered in the receiver in the proper order. This may arise from the operator depressing the keys at a faster rate than the types can be conveyed through the guide-plate. Sometimes, too, the types are brought down to the receiver faster than they can be cleared aside for successive letters. The claims of some makers as to their machines being capable of composing types at any speed at which the keys can be touched, are certainly not corroborated by experience.

These drawbacks, it is right to state, have to a certain extent been remedied in the class of machines called rotary machines. In these the types are ejected in proper order upon a revolving horizontal disc, and are thereby carried to the receiver. These machines are capable of being worked at a much higher rate of speed than the guide-plate machines. In several machines, also, the types have been transmitted, from their place of storage to the receiver, by travelling tapes. Machines of this kind have not proved satisfactory, and have almost gone out of use.

Here may be mentioned another objection to type-setting machines. Some of them cause a great deal of damage to type. In all, unless they are well designed, perfectly adjusted, kept in a proper state of repair, and worked by careful, experienced, and loyal operators, they may break a considerable weight of type. This item of breakage greatly detracts from the economic advantages of type-setting by machinery. Even if the type is not broken, it may be worn unduly. The edges are often rounded by frequent passage through the guide-plate grooves. This wearing especially occurs to the feet of the type, and one result is that they go "off their feet;" and all printers know the trouble this occasions.

It cannot be wondered at, I think, that machines of such delicacy and complexity are very expensive. Their expensiveness does not end with their first cost, it is increased by the per-centage which has to be allowed for repairs. A type-setting machine with its accompanying distributor costs from £350 to £500 and upwards. Only one size and face of type can be advantageously composed with it. I am aware that it is claimed for some machines that they set several sizes of bodies, but the question is, do they do this at once efficiently and economically. If a considerable time is required to make the change the advantage may be nullified. A book printer may use ten or more sizes or styles in his work. The cost of buying an equal number of machines would be very great if not prohibitory. If a machine of this kind is to be even moderately remunerative, it must be kept constantly running. There are few offices, comparatively, in which machines could be kept going without a stoppage for copy or letter. When they are idle, the loss is heavy, not only in regard to the capital sunk, but the waste of the time of the operator. In hand composing a man may have to work in a day from half-a-dozen different pairs of cases. No time is lost in changing from one to the other, but when machines are used every change is a loss.

The cost of running machines and the high rates of wages demanded by skilled operators, is another important drawback to any machine which cannot be depended upon to compose a large quantity of type within a given space of time. A special apprenticeship to them is necessary; for some time the operator, even if he is a practical compositor, cannot produce as much composition as if he were working at case. This deficiency has to be paid for by the employer, and, together with the time absorbed in learning the machine, becomes an important item of expense. Experienced operators, being comparatively few, naturally require higher wages than hand compositors.

So far I have been dealing chiefly with the mechanical problem of setting type by machine, and the mechanical difficulties in the way of its successful solution. I now turn to the economic aspect of the subject. The prices at which printing is done have been enormously reduced during the past half-century. This has been rendered possible, not by reducing wages—for they have increased—but by the adoption of labour-saving machinery. Up to almost the middle of the present century nearly all printing was done on the hand-press. Now, there is hardly an office in the kingdom in which press-work is not done by machine. Yet what do we find in the composing-room? That types are set by hand as they were fifty, one hundred—four hundred years ago. I believe I may say confidently, as the result of careful inquiries, that type-setting machines are to be found in only about a hundred and fifty of the 8,000 printing offices existing in the United Kingdom. Not more than five hundred type-setting machines are, I believe, at present in actual operation.

This fact is the more significant when we remember that type-setting machines have been manufactured and used intermittently for nearly fifty years. During this space of time, several hundred patents for type-setting machines have been taken out. Immense sums of money have been spent in carrying out these patents. Printers have spent large sums in buying these machines. One or two of our greatest printing firms have each spent thousands of pounds upon inventions now entirely discarded. Certainly, printers have shown themselves not to be averse on principle to the employment of machinery.

At the present time, there are six different kinds of type-setting machines at work in this country. Perhaps it would be more correct to say five, as one of them has only been introduced within the last year or two, and is really a machine brought out in America about fifteen years ago, which has since been practically superseded by later machines. Of the other five, three are in use only in the offices of three firms—two of them book firms, one a great newspaper establishment. These, it is said, are doing good work, and doing it profitably.

The only machines now actually offered for sale to the trade are two. One is made in America, as there is not sufficient demand for it to require a factory for its production here. The remaining one is the only English machine produced commercially. There is only one engineering works, and that not of very considerable magnitude, which is engaged in the production of type-setting machines. The really-important patents connected with machines have now all expired, but engineers do not see fit to avail themselves of the fact, and cannot be induced to embark in the business of making such machines.

The reason is perfectly plain. There is not a demand for such machines. There is not a demand for an equally plain reason. The opinion of the great majority of printers—an opinion founded either on their own experience or on that of firms who have tried one of the systems of mechanical type composition—is distinctly unfavourable to them. Although under certain conditions, and for certain classes of work, one or other of these machines may be to a certain extent economical in their results, it has been found that ordinary composition is done quite as cheaply—and more conveniently—by hand as by type-setting machines. When there is an economy effected by using appliances of this class it is not sufficient to justify the heavy first cost of installing machines, of working, and of keeping them in order.

Printers are, to say the least, business men, and in no business is it more essential than in theirs that economy should be practised. If these machines were economical nearly every office in the kingdom doing book or news work would now possess a composing machine—as every office possesses a printing machine. The fact cannot be got over, that while the printing machine is, by reason of its economical working, regarded as indispensable, the type-setting machine is done without, because its economy has never yet been satisfactorily demonstrated.

I now leave machines for composing letterpress printing surfaces by setting up ordinary types, and pass on to that method in which types are entirely superseded. Realising the difficulty of constructing an apparatus for setting up ordinary types, and seeing that attempts to deal with the problem of effecting economy by merely augmenting the rapidity with which types can be set up, have been, more or less, failures from an economical point of view, successive inventors have, for many years past, been working in an altogether different direction. They have carried on a series of experiments with the view of ascertaining the practicability of providing other and quite different mechanical means to the same end. These experiments have only within the last few years led to anything which could be regarded as a practical invention. In the result, however, a most remarkable discovery has been made—that printing surfaces can be formed most rapidly and most cheaply, not by setting up types by a machine, but by composing instead, moveable interchangeable matrices. These matrices have characters engraved upon them in intaglio, that is, hollowed out, and from them plates or bars for printing from are cast. The casts have the characters in relief, as in ordinary stereotypes.

The successive stages by which the new process was developed are three.

In the first matrix machines, the plan attempted was to stamp letters, by means of separate punches, upon a soft, yielding material, like plaster or *papier maché*, and to take and cast from this by the stereotype process. An apparatus of this kind would resemble a typewriter, with a soft, impressionable material, such as what stereotypers call a "flong," to receive the separate impressions of the several letters. This method was found to be impracticable, for several reasons. In the first place, the casts from a matrix thus produced were not suitable for printing purposes, their surfaces lacking in that essential quality of perfect alignment, and absolute regularity and evenness. This was due to the thin dies making a deeper impression than the thick ones; hence the irregularity of the surface of the cast. This difficulty could not be surmounted, even if it were possible to get even surfaces by this method; it would be useless, because the lines could not be justified. The exact space which the letters of a line would occupy could not be conveniently estimated. Hence the lines were of irregular lengths, like those from a typewriting machine. A line thus formed was not adjustable to a given measure, after it was composed; the words could not be spaced out. Apart from these objections, the letter stamps rapidly wore out, and then a good cast could not be taken from them. The plan involved a double stereotyping process, if it were to be used for making the curved plates from which all largely circulated newspapers are printed.

The second stage was entered on when inventors began to set up whole lines of stamps, and impressed them all together upon the flong. This obviated the irregularity of surface arising from the unequal stamping of single letters. It was, however, open to several serious and, indeed, fatal objections. It involved the construction of a more complicated machine. A sufficient number of stamps had to be provided, so that, however frequently in one line a letter was required, there might be sufficient to meet the demand. The letter *e* might be wanted twenty or thirty times, and a corresponding number of dies had to be supplied. These had to be brought into line with great precision, and to be re-arranged or distributed instantly. This involved the construction of a delicate and costly machine. No method was devised of using a dry matrix on which the impression could be made. The plan was most inconvenient, and the results very unsatisfactory, the objection arising from the double stereotyping remained. The dies also wore out very rapidly. It was, as I have said, a great advance upon the class of impression-machines previously invented, especially in one way. The lines could be justified; extra space could be placed between the words, as formed by the dies, and the lines made of uniform length, after the letters of which they consisted were composed.

The third stage of invention was reached when, instead of type dies, moveable matrices were composed—matrices adapted for transposition and re-arrangement. When, with them was combined a casting arrangement, whole lines, properly justified, could be produced in the shape of bars or lines, which corresponded, for printing purposes, to lines formed of moveable type.

Three different machines on this principle have been invented and worked in America. Two of them, however, have been held to be infringements on the patents of the third. As they cannot be worked in this country, they have no practical interest for printers. The third, and the only workable one, is the apparatus known as the Linotype.

The original specification contains a clear statement of the nature of the invention. It related to a machine driven by power and controlled by finger keys, adapted to produce printing formes or relief surfaces ready for immediate use, thus avoiding the usual operation of type-setting, and also the more recent plan of preparing by machinery matrices from which to cast the formes. By the use of the invention, it was stated, the operator is enabled to produce with great rapidity printing bars bearing in relief the selected characters in the sequence and arrangement on which they are to be printed. The machine embraces two leading groups of mechanism: first, those which form a temporary and changing matrix representing a number of words; and, second, those by which molten metal is delivered to the matrix and discharged therefrom in the form of printed bars. The essence of the invention was the changeable or convertible matrix. It was almost as great an improvement on the previous stamping devices as was the invention of moveable types over that of engraving of pages of letters, which preceded typography.

I will not, however, trouble you with any further account of its mechanical details, and will refer only to its economical results as compared with those of type-setting machines as a class.

I will endeavour, with the utmost possible brevity, to explain the chief features of the invention. The Linotype machine comprises mechanism for—first, composing the matrices; second, casting from them when they complete a line of reading matter; third, distributing the matrices of which that line has been composed back again into their proper magazines, in order that they may, again and again be used to form succeeding lines. Then these operations are carried on concurrently—that is to say, while the matrices for one line are being composed the matrices of the previous line are being cast from, and at the same time the matrices for the line before that again are being distributed. The result is that lines of, as it were, stereotyped matter are produced.

The matrices are stored in the upper part of the machine in an inclined magazine with compartments, in which the matrices are assorted. As the magazine slopes the matrices tend to slide downward by gravity out of this magazine.

In the lower part of the machine there is a keyboard and connected mechanism whereby, each time a key is depressed, a single matrix is permitted to fall out of the mouth of the magazine through vertical channels. The matrix then comes in contact with an inclined travelling belt, which carries it and succeeding matrices downward, one after another, into the assembling block, where they are composed or set up, side by side, in a row.

After the line of matrices is thus composed, it is transferred to the cutting mechanism, by which the molten metal is injected into the incised letter of the matrices. The casting bar or mould provides for a bar being cast similar in height and body to a line of types. The bar is finished by knives, which shave off the feet and trim or plane the sides. One after another the line bars are sent into the receiver or galley, where they are made up into columns or pages, like lines of type matter, but with much greater facility than types, the lines being all in one piece.

The matrix is a piece of brass, 1½ inch long by ¾ inch wide. Its thickness is that of the letter or point to which it corresponds. The character it is to produce is punched on to the side, where there is a cavity in which the letter is engraved. At the upper end of each matrix are teeth, arranged in a peculiar order or number, according to the character. That is, a matrix bearing any particular letter differs as to the arrangement of its teeth from a matrix of any other letter.

These teeth are relied on as the means for effecting the distribution or re-assorting of the matrices. Above the open upper ends of the magazine channels is fixed a bar, which has longitudinal ribs on its lower edge. These ribs are adapted to engage the teeth of the matrices, and to hold them in suspension. The ribs of the distributing bar vary in conformation at different points in the length of the bar, there being a special arrangement over the mouth of each channel of the magazine. The matrices to be distributed are simply pushed forward horizontally upon the bar, so as to hang from it. Each matrix is thus suspended until it arrives over its proper channel, and on reaching this point the arrangement of the bar and the teeth permit the matrix to become disengaged, when it falls directly into the channel. Other matrices are meanwhile continuing their course along the bar to their proper points of disengagement. Thus the distribution is done entirely mechanically and automatically.

Justifying is done by what are called "space bars." They consist of two steel wedges, the thicker edges of which are in opposite directions. They slide upon each other, the planes of the outer edges being always parallel. The larger member is about 3½ inches long, and is tapered from about one-sixth of an inch at one end to a knife edge at the other. These spaces are inserted between the matrices of each word as set up, and the long-tapered pieces can be pushed up from beneath afterwards and so spread out the words, making the line of the required measure. This is effected merely by the operator touching a handle.

When the matrix system is adopted, the lines can be automatically justified. Means for mechanically justifying moveable type have often been suggested and attempted, but in all instances without success. The distribution of the matrices, corresponding to the operation of distributing type, is also done mechanically and automatically. In the result, the lines are produced from six to ten times more rapidly than the most expert compositor could put together in his composing stick the types which would be necessary to form an equal quantity of reading matter.

This greatly increased output is obtained not merely by the increased speed at which matrices may be manipulated, but by the possibility of performing automatically, in one machine, the two subsidiary operations of justifying and distributing—the necessity for which, in hand work, so greatly diminishes the output of the compositor. I suppose it would be fair to say that the per-centage of labour cost of the three operations in producing a piece of composition would be—setting the type, 70 per cent ; justifying, 10 per cent. ; distributing, 20 per cent. By using matrices, the second and third processes are obviated, resulting in an economy of 30 per cent. This would be the saving if the speed were only that of hand composing. It is, as a matter of fact, much greater. As one compositor can easily produce 6,000 to 8,000 per hour, it is found that, when all incidental expenses are reckoned, the labour cost of composition is reduced from 40 to 60 per cent., according to management. It should be remembered, too, that as one operator does the work of 4 to 6 hand-setters, the cost of composing-room oversight is considerably simplified and cheapened by the reduction of the number of hands in proportion to the work done.

Within the last year or two improvements have been made which illustrate the capacity of the system. One of them is an arrangement whereby a given face can be cast on a variety of bodies. A nonpareil face may be produced on a minion body, or a minion face on a brevier body. By producing a shoulder on the line bars, "leading" a piece of matter is unnecessary. Thus, solid or leaded matter may be produced from one machine. The other improvement is an even more remarkable one. The machine may be adapted to produce any desired face, from ruby to small pica, by merely exchanging matrices. When it is required to change frequently and very quickly from one face and body to another, extra matrices, magazines, and moulds can be added, and the change can be made in from three to five minutes. One machine, therefore, may produce the different founts used in a news office. It will also produce them in any quantities, provided it is supplied with sufficient metal—the cost of which is about 2d. or 2½d. per lb.

I have time only to briefly mention two other advantages appertaining to the matrix system of line-casting. When types are not used, there is a great saving in the cost of plant. The types produce only a certain superficial extent of matter according to their quantity; the matrices, supplied with metal, will produce an unlimited quantity of matter. Hence, men have not to stand still for want of type or sorts. When matter is required to be kept standing, if it is composed of type, there is involved the expense of keeping idle very costly material. If the matter consists of line bars, the idle material is only cheap metal. Work which requires frequent correction may be kept in the form of line bars, and thus tons, it may be, of valuable type can be liberated for other jobs. Stereotyping is unnecessary, it is resorted to merely to prevent the wear of type, or for the production of a new edition.

I will conclude by saying that an examination of the economic advantages of the two methods of mechanical composition—of that in which ordinary types are used, and that in which moveable matrices are used, must lead to a conclusion distinctly favourable to the letter. Type-setting machines—if I may repeat what I have already mentioned—were introduced into the trade more than fifty years ago. Great inventiveness has been expended on their design, and much mechanical skill displayed in their construction. Immense sums have been sunk in producing them, and in bringing them before the notice of printers. Printers, on their part, have as a class shown no disinclination to adopting these machines, but, on the contrary, have in many instances expended large sums upon them. In not a few offices one invention after another has been tested for a time, and then abandoned, and the old system of hand composition resorted to. Notwithstanding these incontrovertible facts, we find that only in a small fraction of the number of printing offices now in existence is there to be found—after all these years of experience and trial—a type machine of any kind.

What do these facts point to? I believe that they confirm what I have already asserted, that the opinion held by the vast majority of printers is that type-setting of an ordinary kind can be, and is, as cheaply done by hand as by a type-setting machine—that it is only under conditions that may be regarded as peculiar and exceptional that such machines are worked to advantage.

I have mentioned the small number of type-setting machines at present used throughout the United Kingdom, and I have adduced the fact as evidence that machines of the type-setting class have not met the requirements of the printing trade. It is only right to apply the same test to the other and newer system. In doing so I find that although the Linotype machine has been introduced here for only five years, while type-setting machines have been tried for fifty years, there are far more of the Linotypes at work than of all the others put together. The machine is being produced at the rate of six to eight per week. There is another significant fact. There are now hardly a dozen newspaper offices in England in which machines other than Linotypes are used—and in most cases, these type-setting machines were put in before the Linotype was perfected. Some of the leading newspapers have altogether discarded type-setting machines. The rapidity with which the improved system of mechanical composition is coming into general use is most remarkable, especially when we remember that composing machines, of any kind have been so much disparaged and brought into disrepute by the failures of the type-setting appliances during the past half-century. The demand for these Linotype machines also confirms what I have said as to the readiness of printers to adopt machinery, provided only that it can be shown to be profitable.

If I am right in the conclusions I have ventured to lay before you, I am justified in believing that during the latter years of the nineteenth century the possibility and the advantage have been proved of a complete revolution in an art which, in so far as it depends upon the use of types, has remained stationary for more than four hundred years. The economic importance of this fact, and the far-reaching influence it must exert on the business of printing in the immediate future, must be my apology for bringing before the members of the Society of Arts this necessarily brief and superficial, although I hope fair and unbiassed, comparison of the leading principles of machines for composing letterpress printing surfaces.

DISCUSSION.

The **Chairman** said there was no doubt the principle of the Linotype was the right one, because it saved an immense expenditure on the part of printers, but at present he did not think it was the machine for bookwork, though very good for newspapers. As long as authors existed—and when they ceased to exist—there would be no work for printers, the majority of them when they saw a proof would make corrections, and he did not think these could be so made readily enough with the Linotype to enable the book printers to use it. He was not prepared to say that some method would not be invented by which corrections could be made so cheaply that it would be better to recast a whole line, or several lines, or even pages, than to use moveable type. Another objection to it for bookwork was that a careful examination of any specimen of printing sent out by the Linotype Company showed that the face was not free from spots. There was a difficulty in keeping air from the metal, and the result was that the face was not solid. If these objections could be got over the machine would be a great advantage, because it would save such an immense expenditure in plant. He did not think they should altogether discard the idea of machines for setting moveable types. The difficulty was not really in the setting; there were several machines which set type remarkably well, and would be a great success but for the difficulty of distribution. If you distributed the type by hand, after putting it into the cases, it had to be reset in grooves or slots for the composing machine, and this was the difficulty. A good distributing machine was wanted, but directly you came to that you had to have the type specially nicked; and that immediately became a serious question, because the whole plant had to be remodelled and specially nicked. He was not certain that a solution of this difficulty would not be found by using a composing machine, and treating the type in the same manner as the Linotype treated the bars, melting it again. What they wanted was a machine for making type so cheaply that it would not be worth while to distribute it. He had seen a machine, and taken a great interest in it—not financially—which might perhaps be successful, and if it were, it would bring about what was wanted—do without distributing—and always have new type for every book. He did not say the Linotype would not be a success; he hoped it would; but he did not see how to get over the difficulty of corrections.

Mr. **J. G. Wilson** said, if the corrections were the only difficulty, he did not think it would be very great. He examined the Linotype when it first came over, and made up his mind that ordinary corrections could be made or lines re-set quite as quickly as types could be changed. He quite agreed with the Chairman that there would be some difficulty with high-class work, where you wanted perfect alignment, and the face of every letter perfectly clear and distinct. He did not think the Linotype had yet come to that state of perfection, but no doubt it had a considerable future. There were plenty of newspapers, and new ones were started every week; and while that was so it would have the opportunity of making good dividends. He might say that he had worked on nearly every composing-machine which had been invented and brought to this country, and that he had the first machine which came over 50 years ago.

Mr. **Bowerman** said he was much struck with the great saving in wages which Mr. Southward said would be effected in the composing department, but he should like to know if he had taken into account the various extra charges in connection with the machine, which might not be at first sight apparent, but which tended to considerably diminish that saving. He would ask if the saving of from 40 to 60 per cent. was calculated after allowing for these items, such as cost of gas, motive power, and various things of that kind.

Lord **Belhaven and Stenton** said the Chairman had anticipated him with regard to the corrections. He was going to ask how they were made in the Linotype bars.

Colonel **Cunningham** said he had had charge of two large printing offices, where a great quantity of work was done, both by hand and machine, one in India and one in England; and had also been at the Clarendon Press, in Oxford, and seen Bibles printed in all languages, including Chinese. He had spent some time in examining this machine, and was particularly struck with one feature in which it differed from type-writers, viz., that the letters of different widths were presented as in ordinary printing, whereas in typewriters the broad letters and the narrow were all on a body of uniform size, the result to the eye of anyone accustomed to printing being very unpleasant. This machine did three different classes of work—composing, casting the metal in lines, and distributing. All were very beautiful mechanically. In composing, the operator on touching a key opened a passage for a particular type, and down it dropped, and that was the whole of the mental work to be done by the operator; but, in distributing, the machine had to pick out every type and put it into its proper place in the magazine, and the extreme simplicity of the way in which that was accomplished was very beautiful in a mechanical point of view; it almost seemed a mental operation. There was one point on which he should like a little more information. A compositor had to do something more than justify the lines; he had to know when he was coming to the end of the line and make it finish, if possible, with a complete word, or at any rate with a complete syllable, and space out his line accordingly. He understood the operator with this machine could not see what he was doing, and did not quite understand how this was arranged. There must be a great future for the machine in newspaper work alone, where there was not much correction probably, but that difficulty would probably interfere with its use in book work, especially books of a scientific character, where the correction were more likely to be of importance, and to interfere with the length of the lines.

Sir H. TRUEMAN WOOD thought the question of corrections, the author's, not the printer's corrections, required some explanation. No doubt authors inflicted a deal of misery on printers, but in return printers inflicted many weary hours upon authors, and he should like to endorse the remarks of previous speakers on the question of corrections, and to know a little more how these corrections were to be effected. It had been his lot to correct the rough proof of matter set up by a machine, and it appeared to him that the machine had developed a fiendish ingenuity in making blunders to which no merely human compositor had ever been able to attain. They had heard of the mechanism of printing and of type-setting, but a mechanical author was yet in the womb of the future; though some might think that a good deal of modern literature might, as far as its value was concerned, be as well composed by a machine in which you turned a handle, they had not got to that yet. The author always liked to make alterations when he saw his copy in type. No doubt it had happened to many to find that the compositor had greatly improved on their original copy; but still, they did not always approve of his alterations. Now, the addition of a few words or lines could easily be made in ordinary type, but he did not quite see how it was to be done in the Linotype bars. It might often happen that nearly the whole matter would have to be re-set. Anyone who took an interest in mechanics must marvel at the ingenuity displayed in these machines. He had seen a great many type-setting machines, and one Swedish machine struck him as a marvel of ingenuity; it not only set the type, but justified it fairly well, and, in fact, it seemed to him that it could do almost anything but think. He was also shown a machine in America from which type was cast much in the same way as in the Linotype, which was again a marvel of mechanism. But, as a rule, he fancied these machines broke down in the rough work of a printing-office, and it remained to be seen whether this latest offspring of human ingenuity in this direction would survive its competitors.

Mr. LEWIS said he could answer some of the questions which had been asked with regard to corrections and other points, as he had had numerous opportunities of seeing the machine at work and ascertaining its capabilities. He saw a slip of news containing 141 lines of nonpareil corrected in five minutes, quicker in fact than it could have been done by hand. That was the work of an expert operator, the other part of the galley was rather dirty having been set up by an operator not so experienced. There were several points with regard to the machine, both pro and con which had not been touched upon. Some of the statements he had seen in print as to the rate at which the machine worked were not borne out by the information he obtained from offices where it was in use, and he should say as an average it might be taken at 1,600 an hour, an expert would average more, and an unskilful workman considerably less. If you took that as the average, and the price at 3d. to 3½d. per 1,000 as against 7½d. for hand work, you could soon form a calculation of the saving effected, the average speed by hand including distribution being about 1,000 an hour. As against the cost of the machine you could set the saving of type plant, but there were other incidentals, the engineer, power, and occasional stoppages; he had however allowed for stoppages in his average of 1,600 per hour also, and for corrections. With regard to bookwork, again, there were points both for and against, and the question was were they points of principle or workmanship. If the latter they might be improved, but if the former, in nine cases out of ten, they could not. With regard to the spacing, he might observe that in the Linotype all the words were spaced equally, which was not always the best way in practical printing; the spacing should depend on the matter, and that kind of work must be done by hand.

Mr. SOUTHWARD, in reply, said to those who had been brought up in the old way of using types it no doubt seemed a terrible thing to reset a whole line because a comma had to be inserted or a letter altered, but when this machine was looked at it was seen that it was really done much quicker in most cases than correcting a line of moveable type. Then there were not so many corrections to be made. The operator saw the letters quite distinctly as they were arranged in line, and could thus avoid errors. In fact this objection about corrections was theoretical only. Mr. Wilson had borne him out in that. He was sure that anyone who wished to examine into this matter for himself would be allowed to do so by the company. He had been asked what was the saving by using these machines. To give exact figures was always very difficult, and was a matter of some delicacy. Very few proprietors would be prepared to open their books and say exactly what their composition cost; but several had done so, notably Mr. Madge, of the *Globe*, who had a very wide experience of newspaper printing, and he said distinctly at a meeting some months ago, that in his office there was a saving of from 40 to 60 per cent. Several other gentlemen. both in London and various parts of the country, had expressed themselves to the same effect. It would be easy to test the correctness of this by contrasting the price at which men were willing to work by the piece, taking 3½d. for the same body which they would get 9d. per 1,000 for if set up by hand. That showed an immense margin, which was not reduced to any appreciable extent by the cost of working or any incidentals, such as had been mentioned. The motive power was hardly worth taking into account; half a horse-power would run several machines. The metal, of course, required to be improved a little from time to time, but that was a very small matter. There were sometimes stoppages, but as far as he could judge, they depended partly on the way the machine was worked. In an office worked "on the stab" there were more stoppages than where it was worked on piece, because some compositors, if they saw the slightest thing going wrong, if they were paid by the hour, would sit down and wait until someone came and put it right; but if they were paid by the piece, they would manage it themselves. He believed in America the compositors were far more handy in these things, and made adjustments more readily, but perhaps they had had more experience. He could not think they were more clever, as mechanics, than the English. With regard to bookwork, there was really no essential reason why the printing from Linotype should be inferior to any other letterpress. As a matter of fact, some excellent bookwork was done. A few years ago, the printing was certainly not satisfactory, but it had been constantly improving, and there was no reason why it should not be as good as from type. With regard to spacing and justifying, the operator could see exactly what he was doing, and could exercise his judgment in "making even," and so on, just the same as with ordinary type. The question of gas was very small—perhaps 2d. or 3d. an hour—and certainly would not deter anyone from using the machine.

The CHAIRMAN then proposed a vote of thanks to Mr. Southward, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

THE COTTON INDUSTRY IN INDIA.

Cotton has been grown in India for the purposes of manufacturing the clothing of its inhabitants since the time Alexander the Great entered its north-west province. The United States Consul-General at Calcutta says that the "trees," from which the Indians made cloth at that date, are described as plants resembling the dog-rose, with a leaf like that of a black mulberry; they were planted in rows in the plains, and at a distance resembled vines. The natives made garments from the "tree wool," consisting of a cloth about the loins, which reached to the middle of the leg, a sheet folded about the shoulders, and a turban round the head, a method of dress differing but little from the style of the middle-class inhabitants of the present day. From that period until the present generation much cloth has been produced, but little has been exported. The demand, however, caused by the shortness of the world's supply, due to the War of Secession, stimulated both the production and the export. The area devoted to the cultivation of the plant has greatly varied in the last thirty years, caused by the variation in prices, and by meteorological changes, but, on the whole, it may be said that there has been a steady increase in acreage. As far more land is adapted to the cultivation of cotton than has ever been used for that purpose, it would appear certain that if the price of wheat or linseed falls, and that of cotton rises, the change would lead to the claiming of a wider territory by the article advancing in value than it has hitherto occupied. There appears to be a natural adaptation of the Indian cotton plant to the dry climate of India, which enables it by means of its long top root to draw sustenance and moisture from greater depths of the soil than is the case with the American variety, with its number of lateral roots spreading near the surface. Indian cotton is not only finding a new and rapidly increasing market in India itself, but it also has taken a firm hold of the European markets. The competition of American cotton is not the only circumstance which regulates the cultivation of this article in India. Cotton has entered into the regular rotation of crops among a people who dislike changes, and being at all times readily convertible into money is relied upon by the farmer to produce a large portion of the cash required to meet rent and other payments. The varieties of cotton are numberless, but the Indian cotton of commerce is divided into certain well-defined kinds designated according to the localities in which each is chiefly cultivated and distinguished by certain peculiarities of staple. The following are the most prominent:—"Dhollera," "Bengal," "Domras," "Westerns," "Dharwars," "Comptahs," "Broach," "Tinnevellys," "Sind," and "Assam." The total number of hand-looms in the country, and the amount of raw material which they consume, cannot be accurately ascertained. With the increase in number and outturn of Indian mills, and the growth of Manchester trade, the production of the finer textiles of the hand-looms has almost ceased. The manufacture of the coarser kinds for local consumption in rural localities, and of certain ornamental goods, is likely to continue. Cotton is grown both in black and light soils. The black land, or as it is generally called the cotton soil of the country, is a highly argillaceous somewhat calcareous clay, exceedingly adhesive when wet, and from its very absorbent nature expanding and contracting to a remarkable degree under the successive influences of dampness and dryness. While it becomes fissured in every direction by huge cracks in hot weather, it yet retains much moisture as a supply for the roots of the plants. Cotton is seldom grown in the same field oftener than once in three years, the intermediate crops being wheat and millet. With a moderate rainfall the light soil crop is the best. Manure is seldom laid down immediately before sowing, as the natives hold that it should be in the ground a year before the seed is planted. Partly by the hand and partly with the hoe, the field is cleared of the stumps or stubble of the previous crop prior to sowing, and in some parts of the country the plough is run over the land four or five times. About ten pounds of seed are considered sufficient for an acre. The seeds are rubbed in fresh bullock dung, and then dropped through the hollow tubes of the seed-drill. This is followed by the hoe. In many places the seed is sown broadcast; the land is immediately after lightly ploughed, and when the crop has reached some height the plough is again drawn in parallel lines. Land thus prepared is said to require little weeding, for the plough furrows deep and removes roots of grass, &c. Any weeding which may be required is done by hand, and sometimes with a trowel or sycle. When the seed is planted in the first-mentioned manner, the leaves show in six or eight days, and in about a month the plants are three or four inches high. In some districts the seed is prepared for sowing by being steeped in a solution of cow-dung, and when dried in the sun to prevent sticking, is mixed with dry grain or pulse and sown broadcast. For separating the cotton fibres from the seed a simple machine is used, consisting of two small rollers about a foot long, one usually of iron, the other of wood, each with one end turned into an endless screw, and so geared one into the other that when one is turned by a handle the other also turns in the opposite direction. When cotton is supplied to the rollers the fibres are drawn through, and are in this way parted from the seeds. With this instrument a woman can turn out from four to five pounds of clean cotton fibre a day. Consul-General Merrill says that it cannot be said that there is an increasing tendency in India to displace cotton by the use of wool, hemp, jute, flax, ramie, and similar fibres. These articles, when used at all, have their places, and in the case of wool and jute a very large place, yet the inclination to mix them with cotton is not as pronounced as in some other countries.

EAST LONDON INDUSTRIES EXHIBITION.

The prospectus has now been issued of the Exhibition at the People's Palace, to be opened in 1896, of the arts, trades, industries, and handicrafts existing in the Eastern and other industrial districts of London. It will be an extension of the successful one held at the same place during the summer of 1887. It is desired to raise a guarantee fund of from £8,000 to £10,000. More than £6,000 has already been raised with this object, as well as donations to the amount of £1,000. If any profits should accrue, they will be devoted to social and educational purposes in East London. The proposed scheme may be described under five headings:—1. A representative exhibition of the East and other industrial centres of London, with certificates of merit for exhibits awarded by a competent jury. 2. An exhibition that shall encourage—by means of public competition—the arts and industries of individual craftsmen in London. A schedule of prizes will be provided for such exhibitors, in addition to certificates of merit. 3. An exhibition of the work of students at the People's Palace and other polytechnics, technical institutions, and public elementary schools of London generally, and of trade apprentices. Prizes and certificates will be also awarded in this class. 4. An historical loan exhibition, showing the best models of work manufactured in times past. 5. A display of appliances and products bearing upon the social and hygienic welfare of the population, supplemented by popular lectures. There is also a women's section, in which, however, men may compete. It is intended to have a series of concerts and other entertainments, with competitions in music, gymnastics, and other recreative subjects. Lady Jeune has undertaken to formulate suggestions for separate sub-sections dealing with the work of women, and for the encouragement of competitions in needlework, cooking, and other domestic accomplishments. Donations towards current expenses, and guarantee subscriptions may be sent to the hon. secretaries, East London Trades, Industries, and Arts Exhibition, 1896, 64, Cannon-street, E.C.

The Prince of Wales is honorary President of the

Exhibition. The list of Vice-Presidents includes the Duke of Fife, the Marquis of Lorne, the Duke of Norfolk, the Duke of Devonshire, K.G., the Duke of Westminster, K.G., Earl Cadogan, the Bishop of London, Cardinal Vaughan, the Lord Chief Justice of England, the Lord Mayor, the Bishop of Bedford, the Archdeacon of London, the Chief Rabbi, Lord George Hamilton, M.P., Lord Herschel, Lord Iveagh, Sir Walter Besant, and the Warden of Toynbee-hall.

The Executive Committee include Mr. F. A. Hills (chairman), Lord Balcarres, M.P., the Hon. T. A. Brassey, Mr. Spencer Charrington, M.P. (hon. treasurer), the Master of the Drapers' Company, Mr. P. Wootton Isaacson, M.P., Mr. H. L. W. Lawson, Sir Henry Trueman Wood, and Sir William Young. The honorary secretaries are Mr. Harold Boulton and Mr. Ernest Flower, M.P., and Mr. E. H. Lloyd is the manager.

The Ladies' Committee include Countess Cadogan, Lady George Hamilton, Lady Margaret Howard, Lady Rothschild, and Miss Heather-Bigg. Lady Jeune is hon. sec. and Miss T. Mackenzie secretary.

SHADE TREE FOR COFFEE.

The *Kew Gardens Bulletin* contains the following notice of a tree highly esteemed as a shade for coffee in the Republic of Colombia which is taken from a letter addressed to Kew by Mr. R. B. White, dated Palmira, August 6th, 1895. The tree has been identified as *Pithecolobium polycephalum*, Benth., *Hooker's London Journal of Botany*, lii. (1844), p. 219. It extends to tropical Brazil, and was collected near Rio Janeiro by Miers. Mr. White writes:—"I enclose some seeds of a tree which is being used most suscessfully here as a shade for coffee. It has flowers in small white balls just the size of those of the Sensitive plant, pods long, flat, compressed, with 15 to 20 seeds. Pods do not open, being held together by strong marginal veins; they simply break up when rotten. No one here knows the name of this tree. I have referred it to Mr. Lehmann, and he does not know it. It is a native only of Antioquia, and grows in a mean temperature of 75° Fahr. It is fond of stony poor soil. A tree 18 months old will cover 144 square yards of ground (12 × 12). It goes to sleep at night, allowing the dew and cool air to reach the coffee. When young the wood is soft, but on ageing it gradually gets a red heart, and becomes hard and durable. The seed I send has been bathed in sulphate of copper solution, and I believe it to be good, so you can try a few sseds in Kew by way of curiosity and send the rest to one of our tropical establishments to be reported on. When full-grown this tree may be 50 feet high with a spread of at least 50 feet on all sides. Nothing can be better as a shade tree. It is a poor liver and does not exhaust the soil. It spreads out horizontally; it gives a good shade, not too dense, and during the night allows the dew to refresh the plants beneath. The leaflets do not litter the plantation, and are too small to harbour fungi and moulds. It is easily trimmed and brought to shape. The umbrella ants will attack it but they can only get hold of one little sub-pinna at a time. They cannot get a good bite and cut out a real imposing umbrella, and so they do not care to draw much on this tree when once they have balanced up working expenses and output. This is an advantage."

Correspondence.

LOCOMOTIVE CARRIAGES FOR COMMON ROADS.

Mr. CHARLES H. YEAMAN writes:—With reference to my remarks on Mr. Cunynghame's paper (see *ante*, p. 60), I should like to correct two misprints. The weight of the 1888 Ward omnibus, fully loaded and complete, was 3½ tons, not 5½ tons. The name of the gentleman to whom, besides Mr. Radcliffe Ward, I alluded, was Mr. Bersey, not Mr. Bursley.

I think it cannot be known too generally that accumulators have stood the test of 5,000 miles practical running of an electrical vehicle which was operated for two years in some of the busiest parts of London without let or hindrance, and this without any "lubrication" other than that applied to the gearing. The trials began in the spring of 1888, whereas the Pioneer and other companies were formed some time after this.

General Notes.

THE VINEYARDS OF PALESTINE.—The *Journal de la Chambre de Commerce de Constantinople* says that the cultivation of the vine in Palestine has largely increased of recent years. The German settlements established in the country, and certain religious bodies, set an example, which has since been followed by the natives of the place. Hills and valleys, once uncultivated, have been transformed into vineyards, producing both white and red wines, which are much appreciated. The grape is generally white, large, sweet, and agreeable to the taste. Large quantities are consumed on the spot. The sandy soils of Jaffa and Gaza are peculiarly adapted to this cultivation. Hebron, and its neighbourhood, Jerusalem, Bethlehem, and St. John include about 1,300 hectares (about 3,200 acres) of vineyards. Different kinds of brandy, consumed in the country, are also made, the mountain grape, full of alcohol, being peculiarly suited to this particular manufacture. A special brandy of the country is made at Bethlehem; its quality leaves much to be desired, on account of the careless and defective method of preparation. It is to the German settlers—who some years ago introduced some cuttings of American vines—the development of this industry is due. The experiment succeeded, and has produced the best results.

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FRIDAY, DECEMBER 27, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 1 and 8, 1896, by Prof. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements, and Volcanoes."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue.

Proceedings of the Society.

CANTOR LECTURES.

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M.Inst.C.E.

Lecture I.—Delivered December 2, 1895.

With the exception of land and ruins there are few things of any material value to man, which do not derive that value, in part at least, from transport from their original position. Hence means of transport are the greatest aids to riches and civilization, and men seem always to have been agreed on this although they have disagreed as to the means. Even if we go no further back than the beginning of the nineteenth century we find a Committee of our own House of Commons reporting very strongly on this subject in 1808. They did not say that roads and conveyances were of more importance to us than the sun, but they were very near this in opinion. They said "next to the general influence of the seasons upon which the regular supply of our wants, and a great proportion of our comforts so much depend, there is perhaps no circumstance more interesting to men in a civilized state, than the perfection of the means of interior communication." There was no reason then, nor is there now for dissenting from this as a general proposition, but there were in the earlier days of its realization, reasons why it should receive assent in theory but opposition in practice. When carriages became common in this country an Act was passsd to prevent their too general adoption lest the horses should consume the food of the poor.* This was no doubt a sufficient reason at the time, for such an Act, as supplies were not then easily distributed and not much obtained from abroad, but we have the satisfaction of knowing that, cogent as it may have been then, it has no basis in fact now, for the food of the poor is no longer the food of horses and it is certainly of very little direct use to the internal combustion engine or the electric motor.

This question of ways and means however was one which introduced in the days of only horse traction one of the greatest obstacles to increased means of transport. The food of the motor was the food of man, and, as one horse was alleged to consume as much food as eight men, the limit to the number of horses that could be kept upon the work of a given population engaged chiefly in agriculture was soon reached. From the very first, therefore, any means of locomotion which promised to make horse traction unnecessary, acquired great importance as is shown by the interest which statesmen and economists took in them. Few things in connection with the subject of internal communication by roads, are more remarkable than the impartial and broad minded consideration which was given to it by the Select Committee of the House of Commons, which was appointed, in 1831, "to inquire into and report upon the tolls and prospects of land carriage by means of wheeled vehicles propelled by steam or gas on common roads." It was remarkable, because with the exception of some of the leading statesmen, the designers of early road carriages and a very small following, the greater part of the population and nearly all those interested in the then means of road communication, were actively opposed to mechanical carriages of any kind. To an engineer looking over the history of the early 19th century steam carriage enterprise, few things are more striking than the efficacy of the opposition of mere stolid indifference to the requirements of the many, or the unreasoning objection to novelty. When we look at the splendid treatment of the subject and broad-minded views expressed by Tredgold in his treatise on railroads and carriages, published in 1825, it is astounding to find how much there is which, in its practical infancy to-day, was clearly foreseen and, to a great extent, described 70 years ago by this remarkable man. Even the possibility of the use of the gas-engine for traction purposes was entertained by him. Although this was not realised until within the past few years, it was not because the gas-engine was an impossibility, but because of the then far greater perfection of the steam-engine. Tredgold's remarks on the subject were not a mere guess or lightly thrown off imagining of the dreamer, nor was it born of mere enthusiastic hope, as were the lines of Erasmus Darwin, who, in 1765, wrote :—

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* This is stated by Gordon in his Elemental Locomotion but I have not verified it.

> " Soon shall thy arm unconquered steam afar,
> Drag the slow barge or drive the rapid car ;
> Or on wide waving wings expanded bear
> The flying chariot through the fields of air."

The word "soon" here used by Darwin was probably the nearest to measure which would suit an indefinite future. We have enabled or allowed steam to "drive the rapid car," but the road carriage which approached practical completeness in 1835 is not allowed even yet to perform the good services which we now know it might. For sixty years has this powerful aid to locomotion lain dormant. It is impossible to conclude that this neglect can be due, or have been due, entirely to short-sighted opposition on the part of those who conceived their interests to be assailed; and a consideration of the efforts of 60 years ago, makes us ask whether the reasons upon which the present revival of interest in road carriage development is based, are much better founded than they were then. To this point I shall return hereafter, but I may here remark that, however much we may regret the disappointments of the hopes of those who 60 years ago laboured hard to prove the possibility of intercommunication by mechanical carriages on common roads, the intervening lapse of time has not been loss of time. It is a reflection which is often forced upon us, that it is questionable whether in the nature of things it is even desirable that far-reaching inventions should take their full effect rapidly. The history of road locomotion and of railway locomotion, like the history of other fields of invention, has shown that in the development of the most wanted, the development of a thing only less wanted is stopped. These were the relative positions of the railway or railroad, as it was then called, and the steam carriage in the early part of this century.

There can be no doubt that much as improved transport on the high roads, and subsidiary roads was required all over the country early in this century, that which the builders of railways offered and provided was most required. They not only gave the means of somewhat more rapid transport between the great centres of the country, but they offered what is of the greatest value in all things having a commercial basis for their importance, namely, a definite comprehensible and attractive business application for large quantities of capital. There was not the same footing for the steam-carriage, for it did not propose to draw capitalists together in the purchase of lands, and in the establishment of a great monopoly which could perform what could not be performed without it, as the railroads did. The steam-carriage only proposed to do rather more quickly and at somewhat lower cost, precisely what was done by horses. It proposed to use the public roads, and was subject to restrictions and tolls which did not affect horse-hauled carriages, and these tolls were in some cases raised by the turnpike trusts to nearly as many pounds as they could charge shillings for horse-hauled vehicles. It mattered not that it was proved that the horses' shoes cut up the roads much more than the wheels of the coaches.* The opposition had its reasons or prejudices, which were sufficient to crush a new enterprise with no statutory powers. Whether the makers of steam coaches were prepared to do a carrying trade on any scale is a matter which can be best seen by reference to the history of these things, and to this I may now turn, although the history is more of ingenious effort than of success. There is ample reason for dwelling on these failures for a knowledge of them shortens the road to success, as Sir Humphry Davy remarked, but it needs wisdom and discrimination to determine where, why, and to what extent the failure was not a success, and that judgment which is derived from practical experience as well as knowledge, to tell when a failure is due to system or to detail.

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* On this subject a great deal of valuable information was given by Farey, McNeill, Telford, and M'Adam, in evidence before the Select Committee of 1831, not only on this question, but on the widths of tires generally used, the weights of wagons, and the numbers of horses used. See "Historical and Practical Treatise upon Elemental Locomotion," by Alexander Gordon, C.E. London, 1832.

The mere conception of a carriage mechanically driven somehow by steam was shared by a good many whose names and proposals need not be dwelt upon here. Bacon speculated upon the possible use of fire and steam-engines, and drawing-carts without horses was the subject of part of a patent taken out in England, in 1619, by two men named Ramsay and Wildgosse, and the latter was very nearly the name of the chase they both embarked upon. Even Sir Isaac Newton is credited with the invention of a steam-carriage, which was merely a kettle on a carriage, the spout of which was turned rearwards, and, being provided with a horizontal jet piece, formed a single jet reaction apparatus, similar to many of the steam toys with which our children are now provided for a few pence. It was a Hero's steam-engine, with but one jet, and was inferior to Giovanni Banca's steam turbine of 1629. Dr. Robison was impressed with the possibility of the application of steam to carriage propulsion, and discussed the matter with James Watt, but the latter discouraged him, as he did Small and Moore with respect to their proposals, and as he did William Murdock, who had made a really successful locomotive.* In 1790 Nathan Read took out a patent for a steam carriage, in which the pistons of two cylinders were connected to racks which moved pinions on the driving axles, ratchets being used to give motion only one way. This rack and ratchet motion was subsequently used by several others, who made steam-carriages or models of them. Read turned his exhaust jets rearwards, to act as additional propellers after the manner of Newton's jet. As the pressure of his exhaust was probably nearly boiler pressure at the instant of release, each jet would have been as good as Newton's. Read's boiler, like those of many who followed him, bore no relation to the capacity of the cylinders, unless it was that of equality in steam space dimensions.

The first inventor of a steam road locomotive or carriage who really achieved any success was Nicholas Joseph Cugnot, who built one in 1769, and a better one in 1770.† Cugnot was an officer in the French army, and made his carriage with a view to carrying artillery. It was, or is—for it may still be seen in good preservation in the Conservatoire des Arts et Métiers, Paris—a three-wheeled vehicle, the front or single wheel carrying the weight of the engine and boiler being 4 ft. 2 in. diameter. The cylinders are vertical, 13 inches diameter, and the piston rods are connected by ratchets and radius arms to two small ratchet wheels on either side of the front wheel. The steering was effected by moving the whole of the propelling machinery and boiler on a pivot. The latter was, as with all early inventions, too small. It was of copper, and its position made the whole carriage unsteady. Indeed, this was the cause of its being capsized and disused after a brief history of out-of-breath running for a short distance at about three miles per hour.

From the time of Cugnot, inventions too numerous to be mentioned were made, almost all of which were by amateurs whose enthusiasm was in proportion to the incompleteness of their mechanical knowledge or experience. We may pass them all until we come to that of Murdock, of 1781-4. This was a steam locomotive, made only of small model dimensions, but, as a model, it worked satisfactorily, and was remarkable for its simplicity and directness of the application of the power of the motor.* There were in it some points that were essential to success, points which were missed by subsequent inventors, but they were not easy of interpretation from the model to the large scale. He had the direct connection of the long stroke piston to a crank with wheels, which depended merely on adhesion for their tractive sufficiency. He used no gear. Some things which he did not require in a model were necessary in a large size road carriage, but the translation from a model to the larger size, and doubt as to the sufficiency of mere adhesion, put subsequent inventors on a wrong track.

Murdock made one model with a cylinder of $\frac{3}{4}$-inch diameter, and $1\frac{1}{2}$-inch stroke, and of this model carriage Boulton and Watt's agent in Cornwall, Thomas Wilson, wrote to Soho that, "it answers amazingly." This is probably the model presented to the Birmingham Art Gallery by Messrs. Tangye, a copy of which is now in the South Kensington Museum. There is evidence that Murdock made two, if not three, model engines, and it is now known that Boulton and Watt, for their own business reasons, prevented Murdock, who was then their servant, from patenting his engine, or taking any steps to bring it into use. In September, 1786, Boulton, on his way into Cornwall, met Murdock at Gloucester, on his way to London with that object, but Boulton succeeded in persuading Murdock to return to Cornwall, and not waste his time and money in pursuing the steam-carriage notion. On their return to Cornwall, Murdock showed his model at work, and Boulton, writing to Watt, says, "He hath unpacked his carriage, and made it travel a mile or two in River's great room, making it carry the fire-shovel, poker, and tongs. I think it fortunate that I met him, as I am pursuaded I can either cure him of the disorder or turn the evil to good. At least, I shall prevent a mischief that would have been the consequence of his journey to London." Boulton's letters, from which I am quoting, some of which have never yet been published, show that he and his partner highly valued Murdock's services, and as they could not themselves take up the steam carriage or locomotive, they did not scruple to dissuade him from what they thought would be less to their advantage than to Murdock's.

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* See the *Engineer* 10 June, 1881, p. 432.

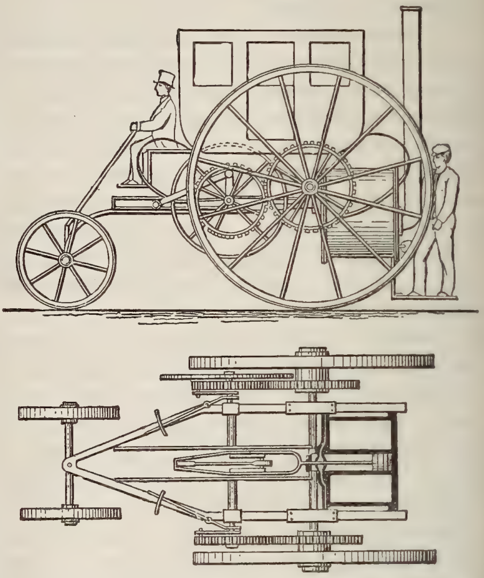
† See "Proceedings Institute Mechanical Engineers," 1853, paper by E. A. Cowper, p. 33.

* See "Steam on Common Roads," by W. Fletcher London: E. and F. N. Spon, 1891.

In 1786, W. Symington, who made the first practical steamboat ever built, patented a road carriage. A cylindrical boiler, with a lever safety-valve, was used in the model of the carriage, and this supplied steam to the cylinder of an atmospheric condensing engine, the piston-rod of which communicated motion by means of rack and rachet-wheel. His arrangement of coach and engine was better than that of some of his followers, but it does not seem to have been carried out, and the rack and ratchet which would have been a fatally defective detail.

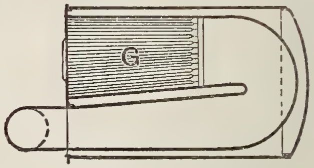
The next inventor who made any appreciable strides towards practical success was Richard Trevithick, a model of one of whose locomotives may be seen in South Kensington Museum. The genius of Trevithick was shown in the remarkable simplicity of the engines he designed and in the proofs that they afford of his sense of mechanical fitness. He was a man of practical experience in connection with pumping engines and mining machinery, and the effects of this experience are shown in his designs both of his locomotive,[*] and in the design of the steam carriage, Figs. 1 and 2. In his locomotive for railroads he used a boiler of considerable size, which is shown in horizontal section in Fig. 3. It was cylindrical in form, and as will be seen contained a large grate within a furnace tube, which gradually reduced in dimensions in the return part which ended in the chimney. He used a long stroke engine with side rods from a crosshead coupled direct to crank pins in the driving wheels. The steam pressure was 60 lbs. and the exhaust steam was turned into the chimney to create a draught. Steam was admitted and emitted by means of a four-way cock by tappets connected with the crosshead, and the boiler was provided with a safety valve and with a fusible plug. As first made the locomotive was provided with the bellows, but this was not used after the first run. Large as Trevithick's boiler was when compared with that of previous inventors, it was nevertheless insufficient in heating surface, a fault which Trevithick avoided in his third attempt, which was the construction of the steam carriage, shown in

FIGS. 1 AND 2.



TREVITHICK'S STEAM CARRIAGE.

FIG. 3.



TREVITHICK'S BOILER.

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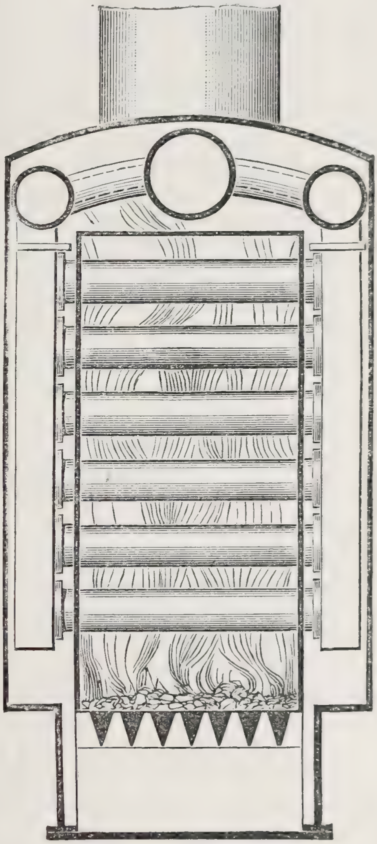
[*] Trevithick's first models were made in 1796-8, end his road carriage in 1802. See Fletcher's "Steam on Common Roads."

Figs. 1 and 2, under a patent granted to him and his friend Vivian in 1802. In this case Trevithick departed from his previous simplicity of design in that he used gearing to connect his crankshaft with his driving wheels, but as in his first small locomotive he used a fly-wheel; but in this case it was placed upon the crankshaft instead of being driven by gear at higher speed than the crankshaft. The carriage, shown in Figs. 1 and 2, seems to have been so far a practical success that it ran a considerable number of journeys at a speed reaching as much as ten miles per hour, but on one occasion, owing to the faulty steering of Trevithick's partner, the carriage ran too close to the side of the road and tore down several yards of palings, an incident which caused considerable expense, and the withdrawal of the coach from the road. After three years spent on these trials, which emptied the pockets of Trevithick and Vivian, the engine was taken from the coach and sold for driving a hoop rolling mill, which it did for many years. It will be noticed that the gearing in this carriage permitted the engine to run at a higher speed than the road wheels, which were of great height, and either of the cog-wheels on the crankshaft could be thrown out of gear so as to leave the road wheels free for turning corners. There is ample evidence that the carriage shown in Figs. 1 and 2 was exhibited at work in and about London for a considerable time, but it failed for reasons which are not at all obvious now; but it is more than probable that it was an inconvenient, noisy, and uncomfortable substitute for the horse-hauled coaches of the time, and these objections, no doubt, lent considerable aid to those who opposed such coaches on other grounds.

From the time of Trevithick, nearly a quarter of a century passed, during which very little of note was done towards the construction of a practicable steam-carriage, although the names of seven or eight inventors are associated with patents, and with experimental attempts to do, in an inferior way, what Trevithick had already accomplished. Several of these, believing that the adhesion of ordinary wheels was insufficient for tractive purposes, designed a variety of ingenious arrangements for propulsion by means of legs and feet, supposed to imitate the action of horses. One of these was by David Gordon, and was patented in 1824. It is unnecessary, however, to occupy any time in describing a failure, which no one in these days would be in the least likely to repeat.

In 1821 Julius Griffiths patented a steam-carriage. It was constructed by Bramah, and the engine and its parts, it need hardly be said, were well made. The coach was carried on a long under-frame, between four road wheels, and the boiler was supported by an ingenious kind of spring suspension from framework at the rear. It is mentioned as the first steam-coach constructed in this country with anything like comfortable accommodation for passengers. The engines consisted of two vertical cylinders, connected to a crank-shaft, which, by gearing, drove the hind wheels at one or other of two different speeds. The boiler consisted of a series of horizontal water-tubes, 1½ inches in diameter and 2 ft. in length, their ends being connected by flanges to flat, vertical water-chambers, as shown in Fig. 4. The water-chambers were connected across the top by transverse and longitudinal tubes which formed the steam receivers and to some extent super-heaters. There were 114 of the cross-tubes, the heating surface of which would be about 89 feet, and

FIG. 4.



GRIFFITH'S BOILER.

this with the surface of the chambers would bring the total heating surface up to from 110 to 120 square feet. It is not however clear from the published accounts whether the ends of the tubes, and therefore the side water chambers, were allowed to act as heating surfaces, or whether they were imbedded in the non-conducting material to the black lines shown in the diagram, and in this case the heating surface would be less than that given for the tubes alone. In the drawings of his Patent Specification (No. 4,630) of 1821, the boiler is shown as consisting of cross tubes connected together at the ends by short bends and not by the chambers. Griffiths' steam carriage failed because of the failure of this boiler, and as described by Alexander Gordon the boiler could not be prevented from priming and the tubes near the fire were intermittently supplied with water and emptied by the generation of steam within them. The result was that the pumps failed to keep the boiler supplied with water and all endeavours to keep it tight at its numerous joints failed. Griffiths used an air surface condenser, which is described as having consisted of a number of thin, flat tubes, exposed to the cooling influence of the air. Contemporary accounts speak of the success of Griffiths' carriage in everything except the boiler, but as this failure never allowed the carriage to go beyond Messrs. Bramah's yard it is not known now whether this condenser was tested or not.

In 1825, a patent (No. 5,090) was granted to Messrs. Burstall and Hill for a steam carriage. A grasshopper engine was used and the boiler was carried at the rear. The beams of the two cylinders were directly connected to cranks at right angles, the main axle being the crankshaft. It was intended to make the front axle also a driving axle by means of the bevel gearing there being a universal joint just in front of the water tank to permit of the movement of the front wheels for steering. The boiler seems to have been again in this case as in others the chief cause of failure. It consisted of a cast-iron fire box the upper surface of which formed shallow dishes immediately over the fire grate. In to or on to these trays water was injected from the feed water tank, which was made to sustain a pressure of about 60lbs. a square inch. This pressure was maintained by pumps which forced air into the upper part. The boiler was in fact of the type commonly now known as instantaneous generators, the shell being of wrought iron surrounding the cast fire box.* The inventors proposed to maintain their flat, vapourising trays or surface at a temperature of from 250 to 600 degrees F. or more, and only allow the injection of the water from the pressure tank to take place when steam was wanted. Thus it was thought they would store heat in this heavy cast-iron fire box top and sides when going down hill or during stops when steam was not being generated. They seemed to think iron better than water for heat conservancy. A good deal of money was spent on this carriage but all the experiments resulted in failure, partly because of the insufficient power of the boiler, and partly because of the great weight of the carriage and its heavy machinery. The engines were said to be capable of giving off 10 horse power. The steam was supplied to them through the coiled steam pipe shown, the flexibility of which permitted of the slight movements of the boiler which was suspended by springs. Similar coiled pipe connection was also used between the pressure tank and the boiler. It is also interesting to note that the exhaust from the engines was passed into what we would now call a silencing box, and its emission therefrom regulated. After the failure of this carriage the authors modified their design considerably, simplyfying the engines, and driving the main hind wheels, by means of cranks outside them, and connecting rods working from the cross-heads of vertical cylinders. They also used a coffee-pot form of boiler, carried in a frame supported partly by the hind axle of the coach, and partly by a third axle, carried by two hind wheels, thus making a six-wheel coach. This arrangement was, however, never carried into practice, except on the small scale of a working model. Timothy Burstall was a very ingenious man, with a good deal of inventive ability, and he made several improvements, for which he took out patents. One of these was for a tubulous boiler, and another for a locomotive, driven by steam reaction wheels; another was for hydraulic propulsion.

In the same year, the subject was taken up by W. H. James, who, in May, 1824, took out a patent for an improved method of constructing steam carriages, in which he disclosed several features of novelty, and of considerable interest, even at this time. He departed entirely from the previous methods of connecting his engines to the road wheels, and he used two tubular boilers, which, in capacity, were better proportioned to the size of the engines. He used four cylinders, 3½ inches in diameter, and with long stroke, coupled to two crank shafts, as shown in Fig. 5, each pair of cylinders and driving wheel being independent, and thus making it unnecessary to use any compensating gear for turning corners. James used a steam regulator, which was operated by the steering gear, so that more steam or less steam was given to either set of engines, to suit the different number of revolutions they would have to make in traversing either the smaller or greater curves in turning. James's boiler consisted of a number of rings of tubes, connected together, and placed, one outside the other, thus forming a series of annular spaces, alternately, of tubes, about three-fourths filled with water and of heated gases, the fire being in the central ring of tubes, which was 1 ft. 9 in. in diameter, and 4 ft. 6 in. in length. A considerable measure of success was achieved with this carriage, but the material of which the boiler tubes (namely, gas-tubes 1 inch in diameter) was made was unsatisfactory, and gave considerable trouble by splitting. The carriage itself moreover, was heavy, and, from repeated alterations, apparently useless. It was, however, sufficient to prove the practicability of such a coach, and it is stated that a journey from Epping Forest into London was made with only one boiler in operation, the coach and its machinery weighing about 4½ tons. In 1829, James constructed another carriage, embodying, so far as the boilers were concerned, the results of the previous trials, but intended more as a traction vehicle than as a carriage. He used, in this case, four boilers of the kind mentioned, made up of nearly 200 tubular rings, measuring in all 400 feet in length of ¾-inch tube, enclosed in a space 4 ft. wide, 3 ft. long, and 2 ft. deep. The steam from each boiler was conducted to a trunk tube above, and from thence to the engines, stop-cocks being placed so as to shut off either boiler from the trunk tube. The cylinders for this second carriage were 2¼ inches internal diameter, and of 9-inch stroke, and they were placed vertically and carried by trunnions. The steam pressure employed was about 200 lbs. per square inch, and the exhaust was at such a high temperature that it melted the solder of two copper tanks, in which it heated the feed-water, and made it necessary to hard solder them. From these feed-water tanks the steam passed to the chimney. Although this carriage was completed, after having acquired the valuable experience of the previous effort, James did not achieve with it the success that the first experiment justified those concerned to expect. It will have been observed from the brief description I have given that he departed radically from the arrangement and design of the engines he first used. James thus made the mistake, which has been made by many inventors since, of throwing away valuable experimental teaching for the sake of new experimental inquiry. He mistook failure in detail for failure in principle, and instead of pursuing that which had achieved a considerable measure of success, he started on a new track, in which he could be but little guided by even the most judicious interpretation of his previous failures.

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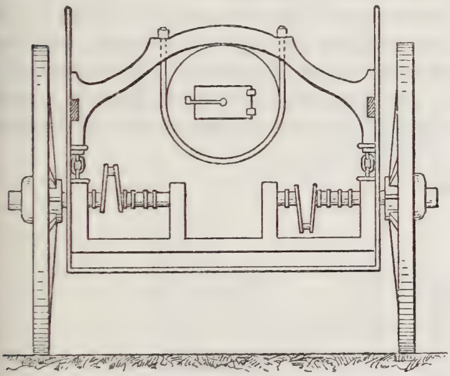
* Hebert's "Engineer's Encyclopedia," 1835; also "Patent Specification," No. 5,186 of 1825. The boiler, according to this, had only one series of closely connected rings of tube forming a large furnace tube. See also "History and Progress of the Steam-engine," by Elijah Galloway. London, 1830, p. 391.

FIG. 5.



JAMES'S CARRIAGE.

Goldsworthy Gurney* was the next to make any important advance, and although he commenced with a steam carriage, impelled by legs moved backwards and forwards by steam cylinders, he subsequently discarded these, and, under patents taken out in 1825, he made several coaches, with some of which he established a regular public conveyance between Gloucester and Cheltenham in 1831. The water-tube boiler devised by Gurney was an essential feature in Gurney's invention, and although there were other good points in his carriage, there is no doubt that he owed his success very largely to this boiler. Figs. 6 and 7 show one of Gurney's carriages intended chiefly as a traction vehicle or locomotive. Fig. 8 shows Gurney's coach in section. This view is sufficient to show the general arrangement of the engine, boiler, connections, and coach. The boiler is shown by Fig. 9, which depicts it in the form it took after several had been made. It is seen in the first form in Fig. 6, which was one of the last vehicles Gurney made. It consisted of a layer of nearly horizontal tubes, which formed a large grate, and these were connected at one end to a horizontal cast-iron trunk tube, which was immediately below a similar horizontal trunk tube, to which it was connected by two vertical tubes, as seen in the large view, Fig. 8. Above the fire was a series of straight tubes, similar to those forming the grate, and connected to them and to the upper trunk tube. Above the upper trunk was a receiver, partly filled with water, and from this the steam was taken off to the engines. In the boiler used in the coach, which is shown by Fig. 8, the receiver or steam-chamber shown in Fig. 9 was not used. Instead of it the upper of the two trunk tubes shown in Fig 9, acted in part as steam chamber, and from it the steam passed into two vertical wrought iron receivers at the back of the coach. These receivers acted as separators and the water in the bottom of them was in communication with that in the lower trunk tube. In the coach short curved pipes led the steam into these separators and from the top of the latter a pipe passing down through the chimney over the top of the space containing hot gasses under the carriage body, conveyed steam to a point immediately under the driver's seat where there was a stop-cock under his control and from which a short length of pipe took steam to the engine cylinders below. The feed pump carried by the rear framing took water from tank seen below the cylinders and forced it through a pipe which was carried into the upper space in the combustion chamber where it was bent into a coil before entering the steam space of the upper horizontal trunk tube. The pipe was convoluted beneath the boiler so as to give elastic flexibility to prevent breakage by vibration. It will be noted that the feed water was heated, and that it entered the boiler in the steam space and not the water

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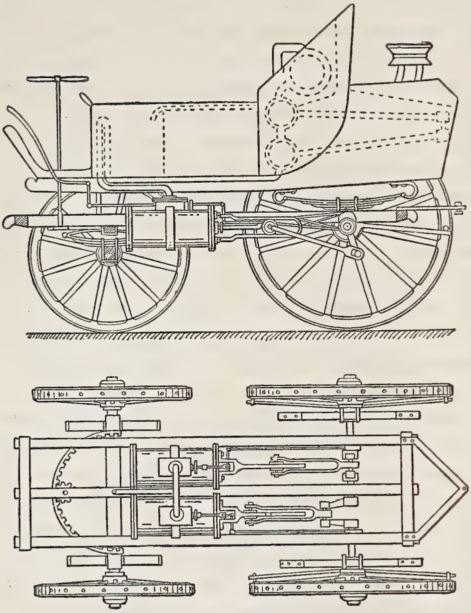
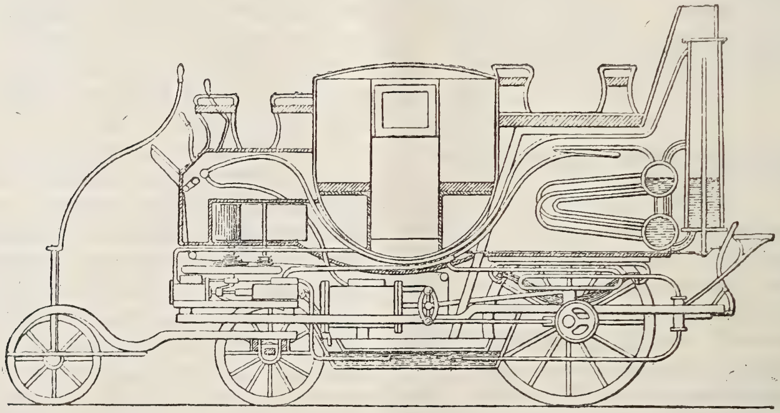
* Gordon, "Elemental Locomotion." Galloway, "History of Steam Engine." Hebert's "Engineer's Cyclopedia." Sir Frederick Bramwell's "Reminiscences of Steam Locomotion on Common Roads," Brit. Assoc., 1894.

Figs. 6 and 7.



Gurney's Traction Carriage.

Fig. 8.



Gurney's Steam Coach.

space. In the front of the coach and under the driver's seat and box is shown a horizontal fan engine. This was used for supplying air to the furnace, but in the last of his carriages, Gurney turned the exhaust steam into the chimney and in this way obtained all the blast required, the exhaust issuing from several jets which were under control. The carriage which is shown by Figs. 6 and 7 was apparently successful as what might be called a light road locomotive but it appears to have been made only a short time before the opposition and prohibitory tolls made it necessary to take the coaches off the road. The steering in them was effected by means of a semi-circular rack attached to the front axle, and into which a pinion on a vertical shaft geared, the top of the vertical shaft carrying a four-way handle.

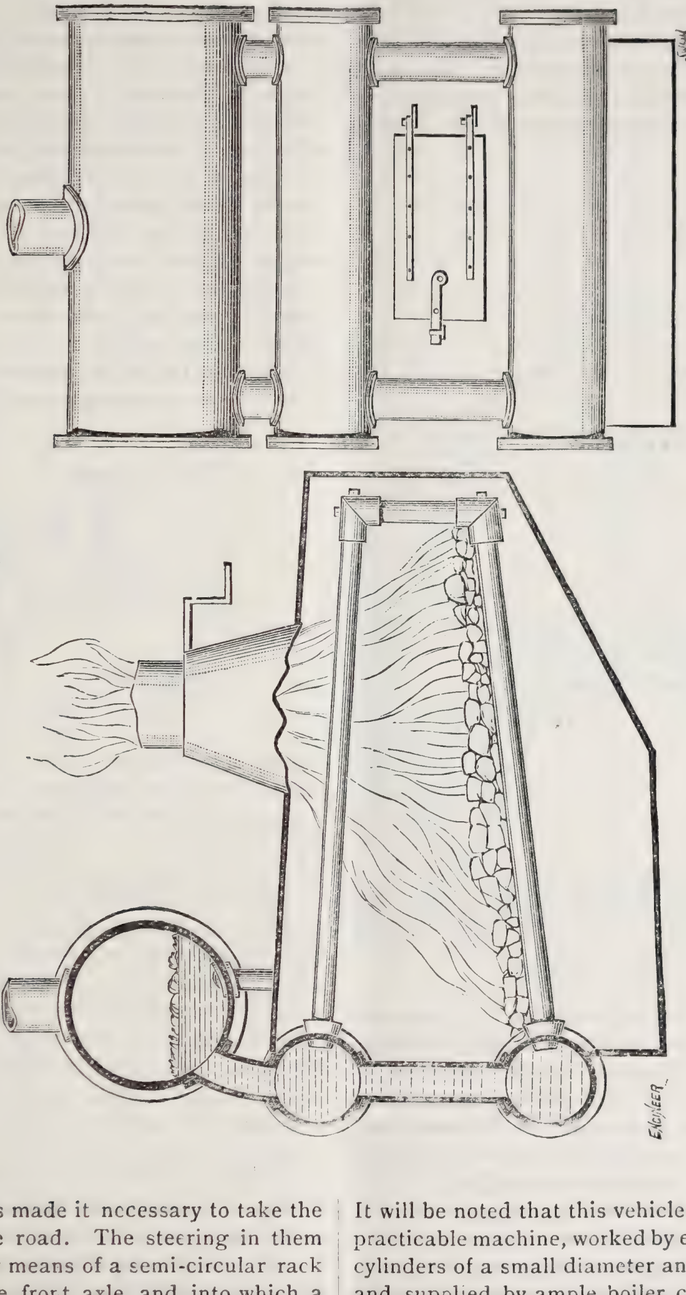


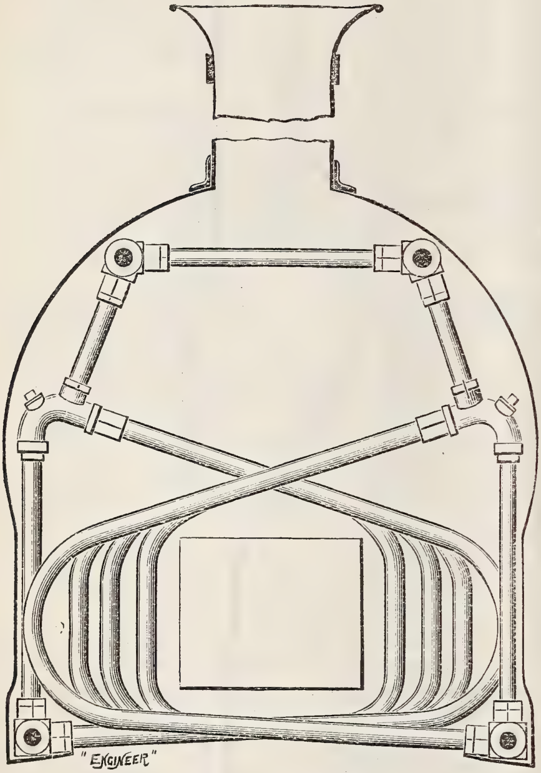
Fig. 9.

Gurney's Boiler.

It will be noted that this vehicle was a simple, practicable machine, worked by engines having cylinders of a small diameter and long stroke, and supplied by ample boiler capacity. The objections which obtained with the hot boiler, steam vessels, and pipes, when forming part of the passenger coach itself, were removed by using this separate steam vehicle which he called a drag.

In 1868 a Dr. Harland, of Scarborough, took out a patent for a steam phaeton, in which the only noticeable point of design is the arrangement of tubes in the front of the vehicle, and forming part also of the coach body framework as an air condenser.

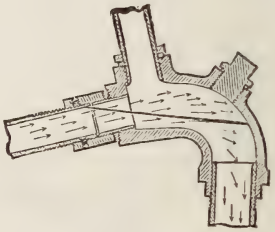
Fig. 10.



Dance's Boiler.

The really successful man, however, in this early 19th century steam-carriage enterprise was Walter Hancock; although some mention must be made of the work done by Sir Charles Dance, who, in 1831, bought and ran some of Gurney's coaches, and, according to the evidence given before the Select Committee in 1831, he travelled with these nearly 4,000 miles, between Gloucester and Cheltenham, the carriages running regularly four times a day, from 21st February to 22nd June of that year, during which time nearly 3,000 persons were carried. At the end of this time the opposition on the part of the turnpike authorities, or, at all events, with their connivance, made it impossible for Dance to continue the running of his service of coaches, the roads being constantly obstructed by heaps of stones put upon them for that purpose. Dance, however, still hoped that something would be done to open the roads for steam carriages, and he sent one of them to London, where he had it repaired and fitted with a new boiler by Messrs. Maudsley and Field, with whom he took out a joint patent for the new boiler, which is shown in Fig. 10. This, like the boiler of Gurney, was a water-tube boiler, and, as mentioned in the description of it by Sir Frederick Bramwell,* had tubes arranged crosswise like a large letter *x*. At the bottom of the legs of the *x* were two horizontal tubes, extending fore and aft the length of the boiler. Smaller tubes started from these horizontal tubes, partly at an angle of about 45 degrees, and so disposed as to pass each other at the centre of the *x*, beyond which they were completed by means of the elbow and junction pieces, shown at Fig. 11, to a larger scale. Within these the water was separated from the steam, the latter passing away by pipes on the top of the junction pieces, which were connected by horizontal cross-tubes, from which the steam in a dry condition was taken. Sir Frederick Bramwell records it as a personal recollection that this carriage worked extremely well, and travelled from London to Reading, a distance of about 45 miles from Hyde-park-corner, in 3¼ hours, towing a full omnibus behind it. It would appear that although Gurney's boilers kept the coaches going for several months, as already described, they were not as good as this boiler of Dance and Maudsley's; at all events, Dance thought it necessary to make this new tubulous boiler.

Fig. 11.



Dance's Tube Joint.

Hancock made a number of carriages of very different forms, one of which is shown by Figs. 12 and 13, and by the large diagram on the wall. It is a rather curious fact that Hancock began by making a steam-engine for a road carriage, which consisted of an indiarubber bag alternately extended by steam admitted into it, and collapsed during exhaust by the return of the crank which it had on its extension pushed outwards. This made a very simple engine, but the material of that which took the place of a cylinder was very soon destroyed. Hancock has described most of his carriages and experiments in the narrative he published in 1838, the tone of the introduction to which might be that of an introduction to a similar narrative published by an enthusiastic man of to day. In fact a reperusal of this old narrative makes one feel inclined to wonder whether the success he records, the public appreciation he mentions, and the report of the Select Committee of 1831 which he quotes, could ever have been other than a dream, and to ask can all mankind have taken a Rip Van Winkle nap of 60 years to find on waking the same questions uppermost in all men's minds as they are now.

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* Brit. Association, 1894. See the *Engineer*, August 17th 1894. *Journal of the Society of Arts*, vol. xlii., p. 781.

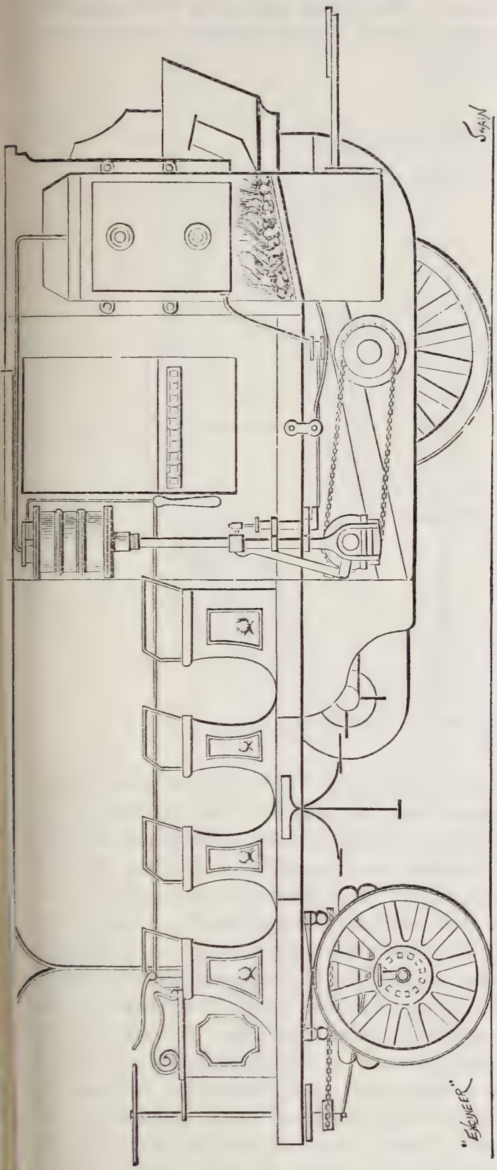
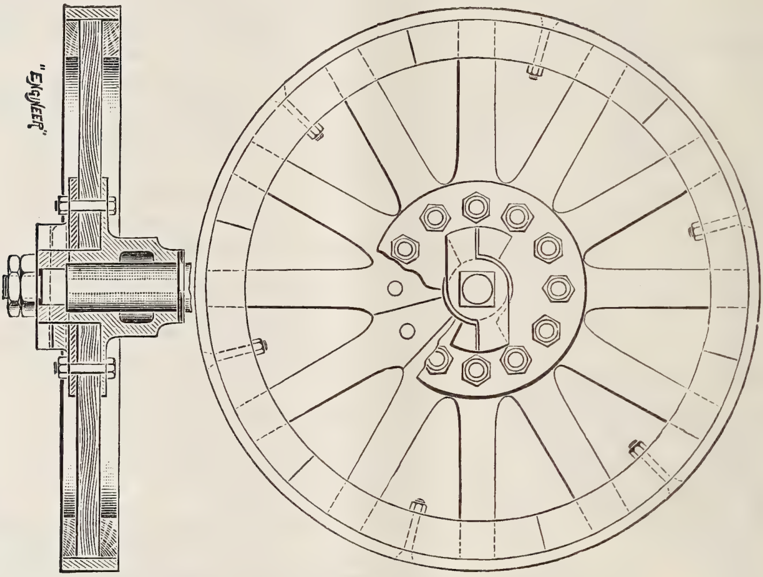


FIG. 12.—HANCOCK'S STEAM CARRIAGE "AUTOMATON."

Hancock was proud of his achievements, but he thought most of his patent for his boiler. He, like all others who had preceded him, had found this element of the steam-carriage most difficult to construct of sufficient capacity and durability. This is shown by a note preceding his introduction to his narrative, which says, "whatever improvements may result from the mode of generating steam by means of flat chambers, exposing large thin sheets of water to the action of corresponding thin volumes of heated air through flues, formed by alternate chambers placed side by side, the writer claims this as the grand principle feature of his invention." Hancock's first carriage appears to have been a three-wheeled vehicle with a pair of oscillating cylinders on either side of the front wheel. It was not satisfactory, but it ran a great many miles experimentally. He subsequently constructed several coaches and other vehicles of the char-a-banc type, such as that shown in Fig. 12. The engines of both were double cylinder vertical actuating their own feed pumps, and driving the axle of the main wheels by means of a stout common cable chain running in wheels of equal diameter of the sprocket order. In each a fan was used in the position shown for promoting combustion in the boiler furnace, the boiler being situated at the rear of the coach as shown, and fed with coke put into a funnel extending from the furnace in such a way that the fire was, to a great extent, self-feeding. Hancock's boiler is shown by the several diagrams of Figs. 1 to 6, group Fig. 14. It consisted of a series of thin or narrow flat iron chambers, the interior surfaces of which were indented or pressed so that when two were placed in contact, these indentations, which took the form of about one third of a hemisphere, came into contact with each other as projections, and left a space between each chamber as shown in Fig. 1, group Fig. 14. The space thus left between each chamber formed the passage through which the products of combustion passed upwards to the chimney. In the diagram the chambers are marked A, and between them the spaces are marked B. A series of these chambers were kept together between stout plates C and girders D through which bolts E were passed to keep the whole together. In the construction of the chambers A the following process was adopted as described by Sir Frederick Bramwell. A flat plate of copper or of soft iron F, Fig. 2, was placed upon a cast-iron slab mould, shown separately in Fig. 3. It was provided with the indentations H H of nearly hemispherical form, and with a larger flat circular indentation H′. Around the margin was formed a raised rim I. Nearly one half of the plate was laid over this mould and, by hammering, was caused to take the forms of the depressions in the mould. Subsequently the other half of the plate was treated in a similar manner, giving the result shown in Fig. 4. The plate was then bent about its middle so that it took the form when rivetted up at the edges shown in Fig. 1. The rivetted edges not being exposed to the fire, the rivets being confined to the top and the two vertical sides. In Fig. 1 of group Fig. 14 the rivetted vertical seams are unintentionally omitted. Each chamber was thus of biscuit bag form, and an alternative mode of construction consisted in rivetting in between the sides of the bent up plate a piece of channel iron, shown at J, in Fig. 5. The circular indentations are from 3 to 4 inches in diameter, and were made to receive copper rings or gun metal, K, Fig. 6, and a narrower ring, K 2, was placed between the upper part of the chamber. The internal dimension of these rings was the same as that of the holes in the chamber plates, and small radial holes were made in each ring. When the chambers were put together, these rings formed tubes, as shown in Fig. 1, the lower one for water circulation, and the upper for steam. Through them were passed strong tie bolts, L, nuts on the end of which bore on hollow sockets, M. When these were tightly screwed up, the whole of the chambers were tightly connected and intercommunicating. The steam to the engine was taken off by a pipe, N, and feed water was pumped into one of the lower sockets, M, as shown in section, Fig. 1; and a pipe, connecting the upper and lower sockets, M M, was provided with guage valves, by which the level of the water in the boiler could be ascertained. For making the joints between the several chambers, copper wire rings were used, somewhat flattened by the pressure produced by the nuts of the tie bolts. Thus, Hancock was the first to make tight metallic joints by this simple means. An external casing surrounded the boiler, as shown in Fig. 12, and this was closed, to receive the air from the fan which was driven off the main engine. The waste steam was blown into the ash pit, and passed up through the fire, so that, except at first starting on a very damp morning, the exhaust steam was

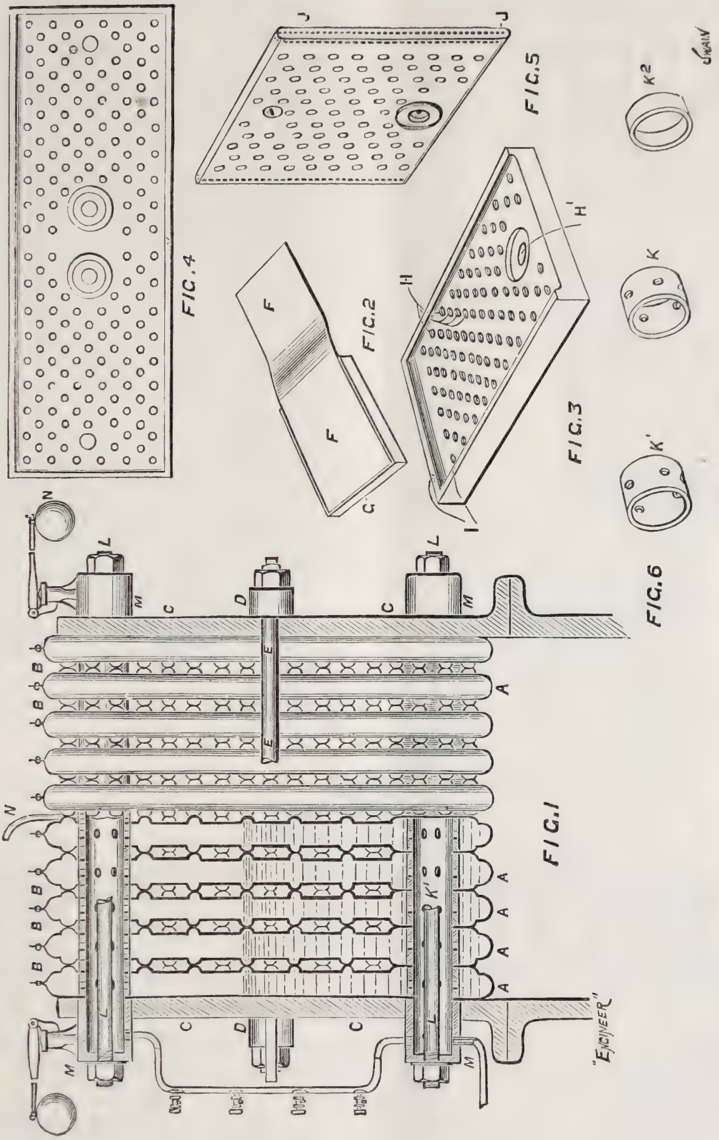
FIG. 13.



HANCOCK'S CARRIAGE WHEELS AND CLUTCH DRIVER.

invisible and noiseless. The steam from the safety valve also blew off into a silencing box.

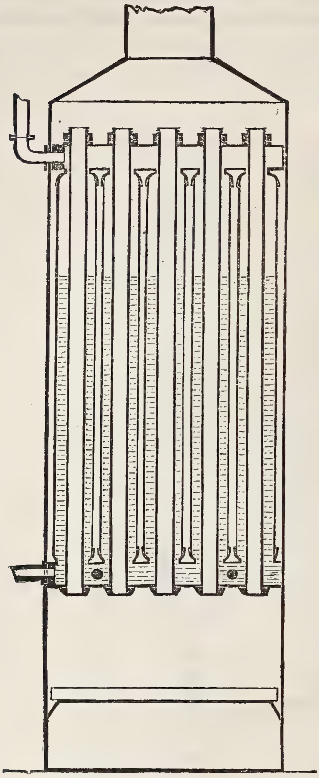
The chain pulley on the engine shaft could be disconnected by a clutch, so that the engines could be used to work the feed-pump or drive the fan. The road wheels were of wood, shown in Fig. 13. They had very strong flat spokes, held between two discs on a cast-iron nave, both wheels being loose on the ends of the axles. On the outer discs were cast two projections, against which a driving piece with similar projections came into contact.



Hancock's Boiler (Group Fig. 14).

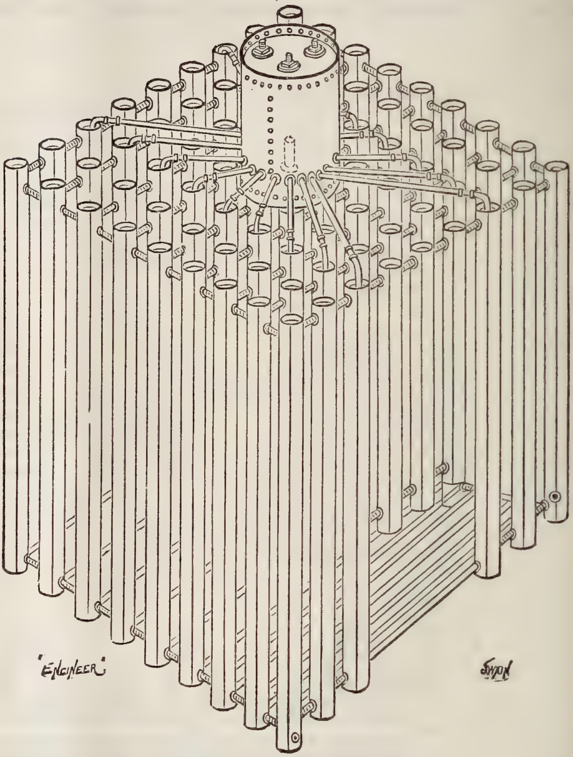
There being only two driving projections on the wheel, the latter was free to move through about 100 degrees as a loose wheel, and this was sufficient to allow one wheel to overrun the other when turning round corners. When a sharp corner had to be turned, however, screws in the driving pieces were taken out to allow of the outer wheel on a curve making one or more revolutions while the inner wheel stood still. To avoid this, Houldsworth's compensating gear or Jack-in-the-box is now generally used on traction engines, and has been employed since 1862, when it was used by Messrs. Carrett and Marshall, of Leeds, in the passenger carriage they exhibited in the exhibition of that year. A similar device was, however, used by Hill in 1840.* Hancock took out a number of patents, that for his flat chamber boiler, describing a similar formation for a condenser, and in the coach which he named the "Automaton," which was nearly his last, he used a condenser so made, but it does not appear to have been a success.

Fig. 15.



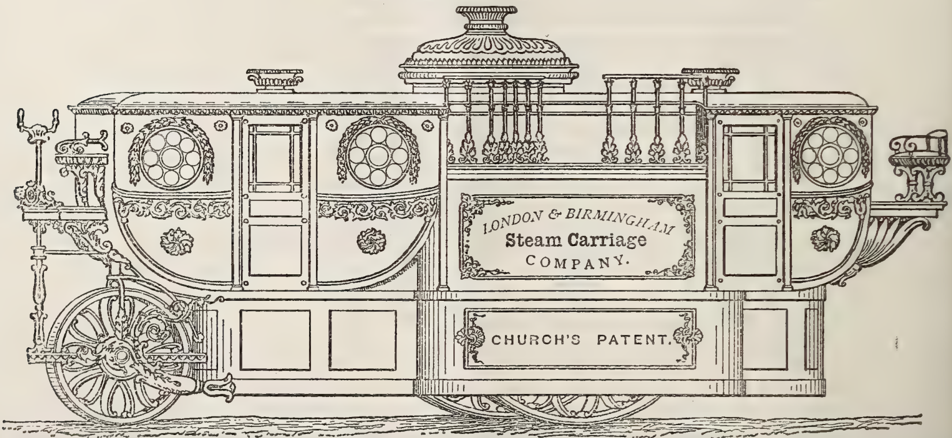
Summers and Ogle's Boiler.

Fig. 16.



Macerone and Squire's Boiler.

Fig. 17.



Church's Steam Carriage.

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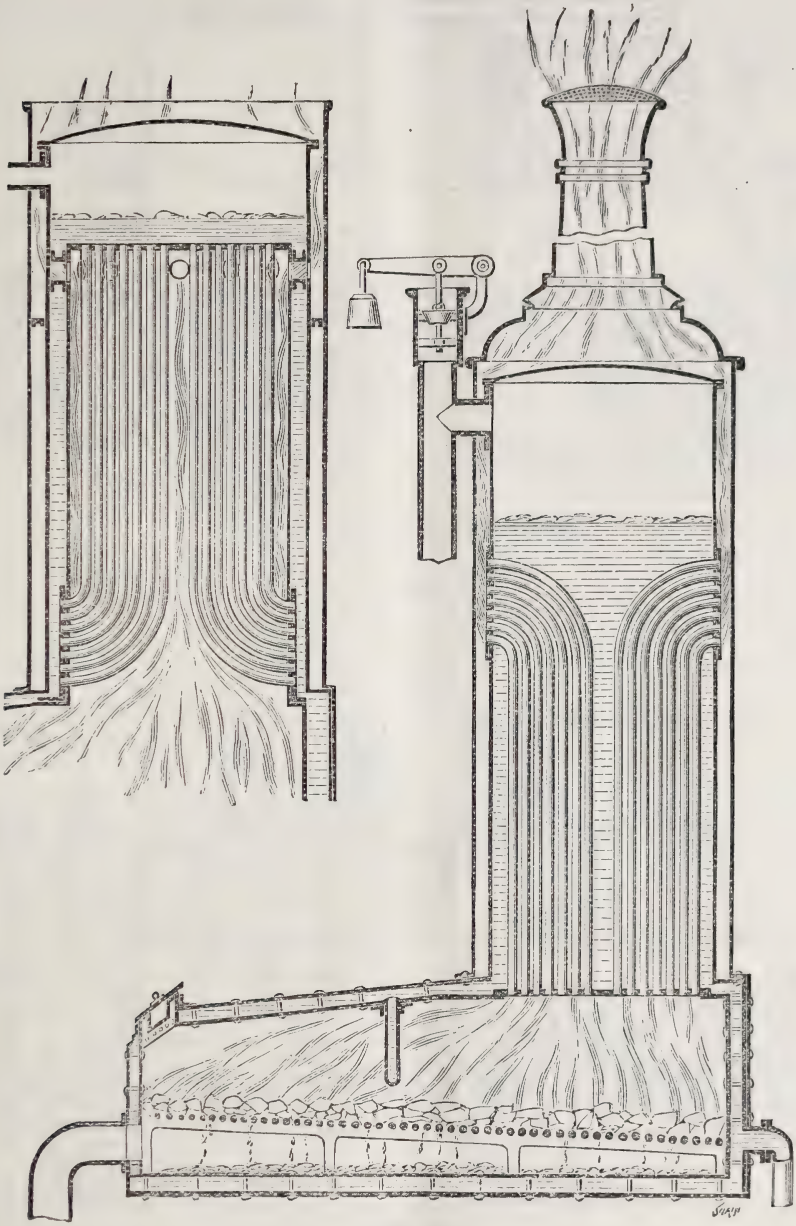
* "Steam on Common Roads," p. 138.

Fig. 15 shows Summers and Ogle's boiler. The vertical tubes were connected to top and bottom D-shaped tubes, and through them passed the smoke tubes. The tubes were $\frac{1}{16}$th inch thick. Proved to 364 lbs.; used at 240 lbs.; weight 85 cwt.; heating surface, including steam space, 245 ft. Their coach worked well, but was abandoned like the rest. Fig. 16 shows Maceroni and Squires boiler, which was the same in general character as Summers and Ogles. Between 1832 and 1835 a Dr. Church, of Birmingham,

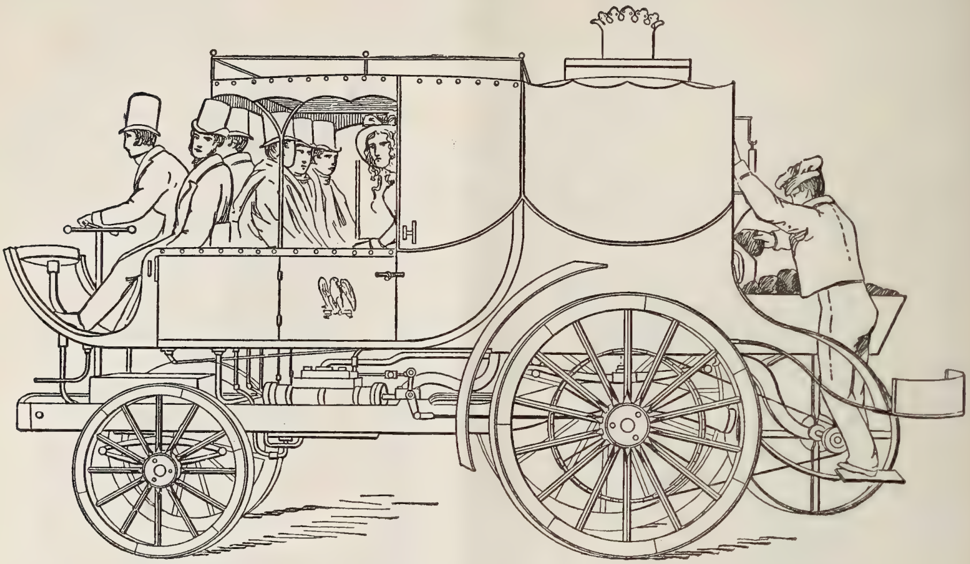
FIGS. 18 AND 19.



CHURCH'S BOILERS.

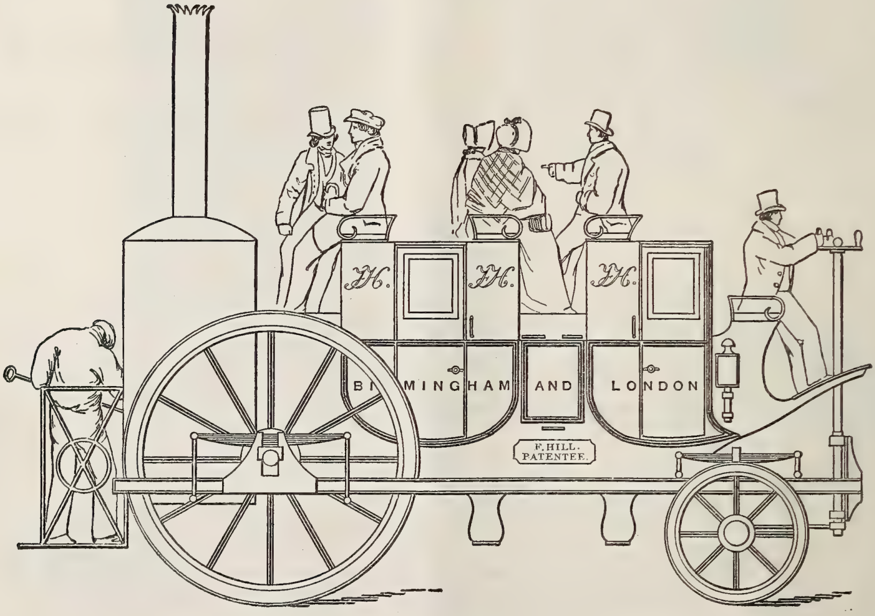
made the elaborate steam-coach shown by Fig. 17. In this carriage Church embodied a great many ingenious ideas. His patent specifications and drawings are documents of great interest as showing early ideas respecting spring wheels and water-tube boilers. The boiler is shown by Fig. 18 (smoke tube), and alternative is shown in Fig. 19 as a water-tube boiler.

FIG. 20.



MACERONE AND SQUIRE'S COACH.

FIG. 21.



HILL'S COACH.

Fig. 20 shows Maceroni and Squire's coach, and Fig. 21 Hills coach. To the coaches of Maceroni and Squire, and of Hill and Church, further reference will be made in the next lecture.

Journal of the Society of Arts.

No. 2,250. Vol. XLIV.

FRIDAY, JANUARY 3, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 1st inst., Professor John Milne, F.R.S., delivered the first lecture of his course on "Earthquakes, Earth Movements, and Volcanoes." He described the various earth movements, and showed by means of a beam of light thrown on the screen the movements which were always going on in a city like London, though they were not perceptible to our senses. By such an arrangement as he exhibited, movements in the crust of the earth could be detected everywhere, the passing of a distant train, or even of a vehicle, caused vibrations which were thus rendered sensible, while the occurrence of an earthquake in a distant country would be indicated. The cause of earthquakes was explained. The crust of the earth is continually puckering up, and when the limit of elasticity is passed an earthquake occurs. It has been supposed that volcanoes act as a safety valve, but the lecturer thought they ought to be considered in the light of danger signals. A map of Japan was then thrown on the screen, on which the earthquake areas were marked. In some of these areas volcanoes were common, but in others they were entirely absent. A series of earthquake instruments were then shown on the screen, commencing with a Chinese instrument used in the first century of the Christian era, also some of the seismic records. Earthquakes were as frequent a subject of common talk in Japan as weather is in England, and an instrument for registering the waves often replaced the clock on Japanese mantelpieces. Some twenty years ago the lecturer visited an extinct volcano, the summit of which was covered with vegetation and overrun with game. A few years later this volcano erupted and destroyed all around, and what was left after the eruption of the volcano was destroyed by the wind that followed the eruption. The lecturer further pointed out that much of the fine scenery of the world owed its origin to earthquakes and volcanoes. Japan suffered greatly from these two destructive agents, but there was a certain advantage on the other side in the creation of the sulphur industry.

The second lecture will be delivered on Wednesday evening, 8th inst., at 7 p.m.

EXAMINATIONS, 1896.

In accordance with the notice given in the Examination Programme, that additional subjects might be added to the next examinations, the Council have now arranged for the holding of examinations in "Economics" and in "Précis-writing." For the former subject, the examiner will be Mr. W. A. S. Hewins; for the latter, Mr. S. C. Paul. Should a sufficient number of candidates present themselves, examinations will be held in Economics on Thursday, March 26th, from 7 to 10 p.m.; in Précis-writing, on Monday, March 23rd, from 7 to 10 p.m. A syllabus for each subject will be found on page 144 of the current number.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Friday, May 17; C. Washington Eves, C.M.G., in the chair.

The paper read was—

JAMAICA IN THE PAST AND PRESENT.

By Frank Cundall.

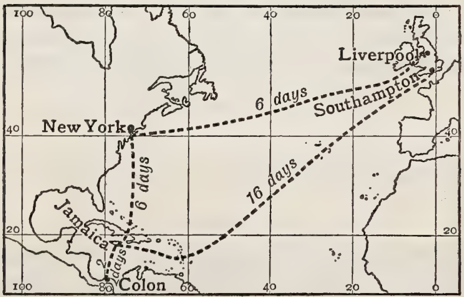
When I was requested to read a paper on Jamaica before this Society, I had considerable diffidence in acceding, for I felt that there were many in London more competent to treat the subject than I am, after but little more than four years' residence in the island, the interests of which are mainly agricultural; living as I have been near the chief town. My only excuse for addressing you this evening is that—in my work at the Institute of Jamaica, an institute the aims of which are much akin to those of this Society—I have come in contact with many of the leading men of the island, and have from them learned much which I could not otherwise have learned without more extended travelling about the country than circumstances have permitted to me.

In speaking of Jamaica to-night, it seems to me that the best plan will be to treat it as a place for immigrants and for transient visitors, taking previously a hasty review of the past; for it is by the past that many of the shadows of the present have been put in—shadows, however, which it is hoped are being lightened by the touch of increasing civilisation and progress. I propose to group my remarks under the following heads:—

1. Geography.
2. History: (*a*) general, (*b*) biographical, (*c*) societies and institutions.
3. Government and laws.
4. Effect of British influence on the negro population.
5. Agriculture, trade and commerce.
6. Colonists and colonisation.
7. Visitors.

I.—GEOGRAPHY.

Jamaica is, as you know, an island in the centre of the Caribbean Sea. Should a ship canal ever unite the Atlantic with the Pacific, it would undoubtedly be considerably increased in importance. The latitude of Kingston is 17° 57′ north, and the longitude is 5 hours 7 min. west of Greenwich. Kingston harbour, the finest in the West Indies, is large enough and deep enough for the whole of the British navy to ride safely at anchor in it.



Walker & Boutall sc.

The island of Cuba is 90 miles to the north; and Cape Gracios à Dios, in the Mosquito Territory, 400 miles south-west of the west end of the island, is the nearest part of the continent of America. Jamaica is 4,193 square miles in extent, having an extreme length of 144 miles, and an extreme width of 49 miles. In its general geological formation, the foundation of the island is composed of igneous rocks, overlaying which are several distinct formations—white and yellow lime-stone, carbonaceous shales, metamorphosed porphoritic, granite and conglomerates, and many mineral-bearing rocks.

Copper exists in many parts. Lead, zinc, manganese, and gold are found in small quantities. Mining operations have been carried on from time to time, but with no great success.

It is very mountainous, especially in the eastern part. The Blue Mountain Peak, 7,360 feet high, is the highest point in Jamaica and indeed in the British West Indies. It is only 200 feet lower than the Pico de Tarquino, the highest point in Cuba; but more than one mountain range in the neighbouring island of Haiti overtops it by upwards of 1,000 feet.

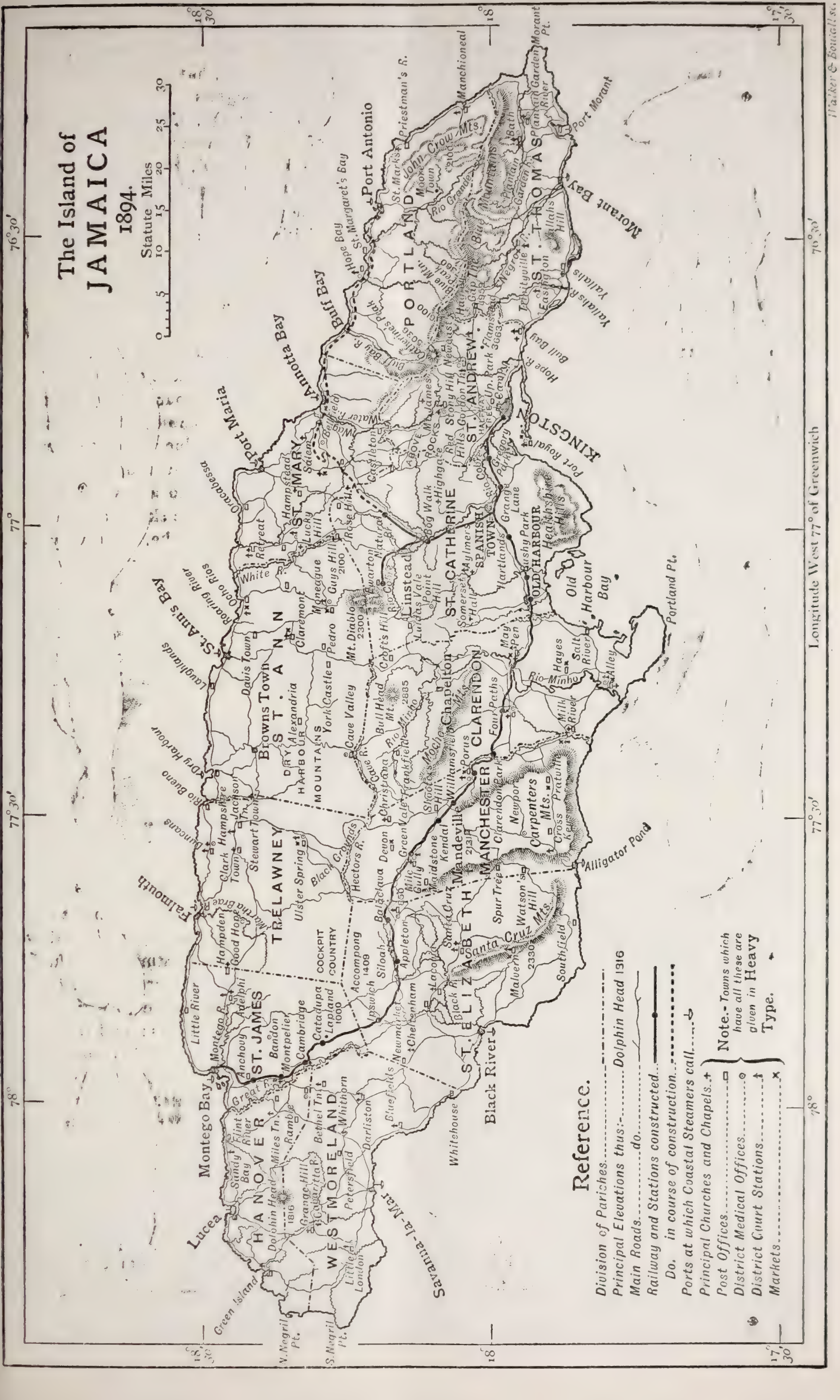
There are numerous savannahs, or plains, on the sea board, and also a few inland shut in by hills on all sides.

Jamaica is divided into three counties, Surrey, Middlesex and Cornwall, and exceeds in area the English counties of the same names by about the extent of Hampshire; but its population is less than a third of that of those four English counties, omitting London.

The population, according to the census, was, in 1891, as follows:—

White	14,692
Coloured	121,955
Black	488,624
Coolies	10,116
Chinese	481
Colour not stated	3,623
	639,491

Giving a population of 152 to the square mile. It is thus more populous in proportion to its size, than Spain, Turkey, Russia and other European countries.


The Island of JAMAICA 1894.
Statute Miles
0 5 10 15 20 25 30
Reference.
Division of Parishes.
Principal Elevations thus:- Dolphin Head 1816
Main Roads. do.
Railway and Stations constructed.
Do. in course of construction.
Ports at which Coastal Steamers call.
Principal Churches and Chapels.
Post Offices.
District Medical Offices.
District Court Stations.
Markets.
Note.- Towns which have all these are given in Heavy Type.
HANOVER
WESTMORELAND
ST. JAMES
TRELAWNEY
ST. ELIZABETH
MANCHESTER
CLARENDON
ST. ANN
ST. MARY
ST. CATHERINE
ST. ANDREW
PORTLAND
ST. THOMAS
KINGSTON
SPANISH TOWN
OLD HARBOUR
Lucea
Montego Bay
Falmouth
St. Ann's Bay
Port Maria
Annotta Bay
Buff Bay
Port Antonio
Morant Bay
Port Morant
Black River
Savanna-la-Mar
Alligator Pond
Old Harbour Bay
Portland Pt.
Morant Pt.
N. Negril Pt.
S. Negril Pt.
Green Island
Mandeville
Linstead
Browns Town
Blue Mountains
John Crow Mts.
Carpenters Mts.
Santa Cruz Mts.
DRY HARBOUR MOUNTAINS
COCKPIT COUNTRY
Longitude West 77° of Greenwich
78°
77° 30'
77°
76° 30'
18° 30'
18°
17° 30'
Walker & Boutall sc.

The births for 1893-94 numbered 27,365, giving a rate of 40·9 per thousand on the estimated mean population. The deaths for the same period numbered 14,885. The rate, 22·2 per thousand of the population, compares favourably with many English towns.

Included in the government of Jamaica are the Turks and Caicos Islands, which geographically form part of the Bahama Islands, to which they at one time belonged; the Cayman Islands, which lie from 110 to 150 miles north-west of the west end; the Morant Cays, about 33 miles south-east of the east end of the island, and the Pedro Cays, about 40 miles south-west of Portland Point, the most southerly point of the island.

The inhabitants of the Turks and Caicos Islands (about 5,000 in number) live almost entirely by the salt industry, the salt being made from the sea by evaporation in salt ponds, which form a large part of the area of the islands; those on the Cayman Islands, who are in the happy position of having no pauper roll, by turtling. The Morant and Pedro Cays, which are uninhabited, are leased for the purposes of collecting guano, boobies' eggs, turtle, &c. Turks Islands are reached in two days by the steamers which go monthly from Jamaica to Halifax.

Jamaica and its dependencies comprise a little more than a third of the area, and contain nearly a half of the population of the British West India Islands.

II.—HISTORY.

When Columbus, in 1492, and the succeeding years, on his search for a western route to India—a search the memory of which ever lives in the title "West Indies"—discovered the New World and explored the Antillean Islands and a small part of the southern continent of America, he found them peopled by several tribes of natives, of which the most important were the Caribs and the Arawâks. The former, a fierce, man-eating people, who have given their name to the Caribbean Islands and Caribbean Sea, inhabited the mainland in the neighbourhood of Guiana, and the Lesser Antilles (the Windward and the Leeward Islands, as we now call them); and the latter, a quiet, inoffensive tribe—as their name, meal-eaters, signified—resided in the Greater Antilles—Puerto Rico, Haiti, Jamaica and Cuba, whither they had probably come in pre-historic times from the southern continent of America.

The Caribs had, by the last decade of the 15th century, driven the Arawâks from the Lesser Antilles, and would probably, but for Spanish intervention, have forced them to also leave the larger islands.

On his first voyage, Columbus discovered several of the Bahama Islands, Cuba and Haiti. On his second, starting in 1493, he discovered the northern islands of the Lesser Antilles (the present Windward Islands), and, after re-visiting Haiti and Cuba, struck south in search of an island which he was told possessed much gold, and discovered Jamaica on the 3rd of May in the following year. He said of it, "that there was no gold in it or any other metal, although the island was otherwise a paradise, and worth more than gold." On his landing at Dry Harbour, on the next day, the natives offered some slight resistance; but this was probably due rather to timidity, which had been accentuated by the persecutions of the Caribs, than to any active hostility to the strangers from the skies, as they considered the white men to be, when they found them unlike their cruel foes; but they were bitterly undeceived by subsequent events. For the moment, however, they were easily pleased by gifts of beads, combs, knives, hawks'-bells and other nic-nacs, and freely brought fruits to the Spaniards, and gave them all the help they could.

On his fourth and last voyage, Columbus ran his weather-beaten and worm-eaten caravels aground in St. Anne's Bay; and, during an enforced residence of twelve months, he and those with him would, under ordinary circumstances, have had ample opportunity of studying the habits and customs of the natives. But he himself was racked by gout, worn out in mind and body by travel and by revolt amongst his followers, disappointed in the treatment he had received from Ferdinand and Isabella, and too anxious about the future to devote much time to descriptive accounts; and the reminiscences of Mendez, one of his companions, are taken up for the most part with that worthy's own achievements. Moreover, to the absence of gold, which metal formed the principal attraction of Haiti in the Spaniards' eyes, is due the comparative inattention with which Jamaica was treated by the Spanish historians. What writers have failed to tell us about the inhabitants of Jamaica, we must, therefore, in part supply from the accounts of the Arawâks in Guiana, where they have survived until to-day.

Columbus gave to the islands which he discovered names in honour of his sovereigns, the saints, some towns in Spain, or the day of discovery; but in some cases the aboriginal names have survived. Jamaica is one of these. The word is thought to be composed of two native words meaning wood and water, implying fertility.

We can, without much difficulty, picture to ourselves the appearance of the island as Columbus saw it, for there are many tracts of virgin forest and uncleared bush which must to-day resemble the features which they presented to the explorers of 1494; and the humblest form of a house to-day, is not, when viewed from a distance and through trees, very different in outward appearance from the habitation of the Arawâk. Seen from the sea, the physical features of the island were of course what they are to-day. It is probable that in parts the trees and undergrowth were as thick as they were in Guadeloupe, where Columbus tells us some of his seamen lost their way for days; and this thick growth was conducive to a humid atmosphere, and a less parched appearance in the drier seasons.

Then as now the giant cotton tree, one of the few deciduous trees in the island, reared its head above its fellow trees; and prominent in the landscape were, to name but a few, the cocoa-plum, the calabash, the antidote cacoon, the locust tree, the prickly pear, the allspice-yielding pimento, and the guava; in the interior were the wild olive, the lace-bark, the yacca and the mahoe (both beautiful cabinet woods), the mountain gauva and the ramoon; while the seaside grape, with its large, decorative leaves and hanging bunches of dark-blue berries, was a prominent feature on the seashore.

Then, as now, the scene was made gay with the annatto, with its rosy-coloured flowers and purplish pods, the West Indian ebony with its yellow flowers, the pale blue of the lignum-vitæ bloom, the golden bronze of the under-surface of the leaves of the star-apple, the hanging purple bunches of the bastard cabbage-bark tree, the yellow and purple portulacas, the yellow "kill-buckra" weed, the pink shame-weed, the red and yellow of the Barbados pride, the yellow of the Jerusalem thorn, the purple pyramid of the mountain pride, and the brilliant golden candelabra-like spike of the coratoe; by the various specimens of ipomœa, with their several blooms of white, yellow, red and purple, the rose-coloured Jamaica rose, the white trumpet-flower, the bright red Indian shot, the blue Jamaica forget-me-not, and many another brilliantly-flowered tree, creeper and shrub. Some afford excellent woods for cabinet-maker and carpenters, but their practical use is almost nullified by the cost of cutting and carting; others yield dyes, or are useful in cookery and medicine.

Amongst the chief food-plants and fruit-bearing trees were the cassava, the Indian's chief staple of food; the mammee, with fruit of a russet brown, larger than an orange; arrowroot; the guava, the fruit of which, made into a jelly, is world-famous; the naseberry, with a fruit not unlike a medlar both in appearance and taste; and the papaw, with its straight stem and fruits like pumpkins hanging just beneath the crown of leaves.

Of trees and plants now common in the island which we know were not there when Columbus landed may be mentioned the sugar-cane; the pindar nut, which came from South America; the jack-fruit, from the East Indies; the ever-useful and beautiful bamboo which came from the neighbouring island of Española; the orange and lime, from Spain; coffee and kola and akee, which came from tropical Africa; various kinds of yams from Africa and the East Indies; coco from Polynesia; the shaddock from China; the cinnamon and the mango, now one of the commonest trees on the island, which came to Jamaica in 1782; genip, a native of Trinidad; the nutmeg, rice, and the bread-fruit which was brought in 1793 by "Breadfruit" Bligh, who possibly also brought the banana; although the plaintain was in the island when Blome wrote in 1672. It is not certain whether the cocoanut palm was there or not.

That in the exchange of trees and fruits between the old world and the new, the gain was not all on the side of the old, was evident to Acosta, who published, about 1590, his "Historie Natural y Moral de las Indias," a work full of valuable information about the state of the new world at the close of the 16th century, and who says:—

> "The *Indians* have received more profit, and have bin better recompensed in plants that have bin broght from *Spaine*, than in other merchandize, for that those few that are carried from the *Indies* into *Spaine*, growe little there, and multiply not; and contrariwise the great number that have beene carried from *Spaine* to the *Indies* prosper wel and multiplie greatly."

And it is interesting to note that, of the principal crops of Jamaica of to-day, that of the pimento is the only one from an indigenous plant.

Of animal life in Jamaica, there were, amongst the mammals, only the coney, which is fast becoming extinct; a mute, dog-like animal, which the Indians called *alco*, and of which no trace exists to-day, and possibly the rat. It is said that the armadillo was once found in all the West India Islands, and the racoon was there as late as Sir Hans Sloane's visit in 1687. But the opussum and the peccary, though formerly in the Caribbean Islands, were not known in Jamaica.

The coney, which is very shy and difficult to catch, is now only seen in the rocky recesses of the mountains of Portland and St. Thomas, and is seen there but rarely. In appearance, it is something between a rat and a rabbit; it is about six inches high at the shoulder, and dark brown in colour.

The natives used as food, besides the coney, the iguana lizard, and probably the mountain crab, which is still considered one of the delicacies of the island; but it is thought that they did not eat the flesh of the manatee and turtle; the former is not now nearly so common as it was.

There were no horses, cattle, sheep, goats, pigs or poultry in the island when Columbus discovered it, all of which were introduced by the Spaniards at a later date.

Of bird-life, there were the same specimens as we know them to-day, only in greater profusion—the parrots being especial favourites with the Indians, who kept them in their huts. But Columbus was probably exaggerating when he said that flocks of them hid the sun.

Forty-three of the birds of Jamaica are presumed to be peculiar to the island: the chief are the quail, the mountain partridge, the Jamaica heron, ducks and doves and pigeons, several of which are very good eating, the ring-tail pigeon being considered one of the island's chief delicacies.

The humming birds are perhaps the most noticeable from their beauty and graceful movements, as well as from the fact that they do not hesitate to hover around the flowering creepers that grow on almost every dwelling.

One of the most interesting features in the natural history of Jamaica has been the introduction of the mongoose, which was imported about twenty-three years ago to keep down the rats which were so harmful in the cane-fields. The mongoose did his work well, but unfortunately he did not stop there. He then turned his attention to the snakes, lizards, small birds, turtle eggs, domestic poultry and their eggs, and ground provisions; and became almost as great a scourge as the rabbits in Australia or the historical rats of Hamelin. If any pied piper would arise and rid Jamaica of the mongoose, he would doubtless have a statue erected to him by a grateful people. By the destruction of the small birds, the mongoose is said to be the cause of the immense increase of ticks, the greatest pest in the island. It is now, however, reported from various parts that the ticks are killing the mongoose—a fitting retribution. At all events, the history of the mongoose in Jamaica is a standing warning to any who would lightly upset the balance of nature in any country.

Then, as now, the sea around the coast teemed with numerous food fishes, excellent in their way but lacking for the most part the flavour of fishes in temperate waters. The mountain mullet, however, the finest of the river fishes, rivals many English fish in delicacy.

As in Haiti, the natives of Jamaica were ruled over by caciques or chieftains. The estimates of historians of the number of inhabitants in the West Indian Islands differ widely. Las Casas, who says that the island abounded with inhabitants as an ant-hill with ants, puts them down at six millions. But Peter Martyr gives but 1,200,000 to Española, and, taking this as a guide, there would probably have been about 600,000 in Jamaica—or, roughly speaking, the same as its present population. Of these, but few remained when the English took the island in 1655; and but few remains are left to testify to the existence of a tribe which not so very long ago lived by gathering the fruits of the land and sea of Jamaica.

Judged by the English standard, Indians are short in stature. The Arawâks of Guiana to-day are described as being of a red cinnamon in colour. The hair on the scalp is thick, long, very straight and very black. The features of the face are strikingly like those familiarly known as Chinese (Mongolian), and the expression is decidedly gentle. Physically they are weak, and life hardly ever exceeds fifty years. The natives of Jamaica—as a few skulls found from time to time testify—possessed, in common with other West Indian tribes, one peculiarity, that of tying boards on to the foreheads of their children in such a way that the skulls assumed and permanently retained an extraordinary flat shape.

Peter Martyr, who heard it spoken, said that the language in the Greater Antilles was "soft and not less liquid than the Latin," and "rich in vowels and pleasant to the ear." Of words of West Indian origin, those most frequently in use in the English language are barbecue, buccanier, canoe, carib and its derivative cannibal, guava, hammock, hurricane, iguana, maize, manatee, pirogue, potato and tobacco.

Columbus has told us of a cacique of Cuba who believed in a future state dependent on one's actions in this world; but Mr. im Thurn has found nothing of the kind amongst the Indians of Guiana, and it is probable that Columbus's guide from Guanahani only partially understood the cacique, or that Columbus only partially understood his guide. Their houses were primitive alike in shape and construction. In Jamaica, they were probably circular, and were provided with walls of wattle work plastered with mud, and with a high-pitched roof of palm-leaves; they probably had no windows. The Indians sleep on hammocks. The weapons of the Arawâks of Jamaica and the other large islands consisted of darts and war clubs; but they apparently did not possess bows and arrows which were the form of weapons prepared by the Caribs, and the use of which gave them a great advantage over their more peaceful foes.

Ornaments were more worn by the men than the women. Painting was the simplest form of ornamentation; the colours used being blue, black, carmine, white and yellow, derived from plants and earths. They wore necklets of hogs-teeth and stone-beads, crowns of feathers in their heads, aprons of palm-leaves or woven cotton; and bands round their arms and legs. Their chief occupations and means of living were hunting and fishing and agricultural pursuits, with, in some cases, a certain amount of trading. As they required nothing more than canoes for travelling on the water, simple houses to live in, baskets for domestic purposes, hammocks for rest, rude weapons of the chase, and implements such as hatchets and chisels, earthen vessels, and a few ornaments and articles of dress, these form the sum total of their arts and manufactures.

All that we have left of these to-day are a portion of a canoe (discovered last spring in a cave, in St. David's, with some skulls), a few stone implements, pieces of pottery, and, here and there, a bead ornament. Quite recently other important discoveries have been made: one, also in St. David's, of some interesting pieces of pottery; a second of some rock carvings in St. John's, a district which was apparently a favourite one with the native Indians (these carvings are not far distant from where a cave, containing pots and urns and human bones, must have been, which Sir Hans Sloane visited in 1688); and a third on Goat Island in Old Harbour Bay, of a human skull placed in an earthen vessel.

The Spaniards remained in possession of the island for about a century and a half. At Columbus's unhappy suggestion, criminals had been sent as colonists to the New World on his third voyage, and this class of people, with needy adventurers whose sole aim was the acquisition of riches, proved no good material out of which to form a colony. Columbus, too, unhappily proposed that cannibals and prisoners of war should be sent to Spain for the good of their souls in exchange for cattle; and this expatriation, together with the cruelties practised on them by the Spaniards in their greed for gold, soon led to the extermination of the natives.

Then the fateful step was taken of importing slaves direct from Africa, and a legacy was bequeathed to the West Indies, the evil effects of which were not to be removed for upwards of three centuries.

It is estimated that when Jamaica fell into the hands of the English, the population of the capital was half Spanish and Portuguese or their descendants, and half slaves; but it is a curious fact that a negro is mentioned as holding the position of priest of the Romish Church.

The more important islands of Cuba and Haiti, to say nothing of the rich mines of South America, offered greater attractions to the Spaniards than did Jamaica, where—then, as now—the field had to be ploughed before the harvest could be reaped.

Beyond the introduction of several kinds of useful fruits, and of horses, cattle and pigs, and the names of many settlements, rivers, mountains and plains, there is now little more to speak of the Spanish occupation, than of that of the aborigines, who were practically exterminated under their rule. Towns and churches were built, but they have all passed away; and there are now but scanty remains of Spanish masonry in the island; none of great importance.

If Spain utilised criminals in the colonisation of her possessions in the New World, some of the men whom Cromwell sent out under Penn and Venables, to "obtain an establishment in the West Indies, which is possessed by the Spaniards," in order to put a check on Spanish arrogance, were little better. One of their number characterised them as "Hectors and knights of the blade, with common cheats, theeves, cut purses, and such-like leud persons;" and, in connection with the cowardice at San Domingo of Adjutant-General Jackson, who had his sword broken over his head as an example to others, he stated that, in his opinion, "if all of like nature had been so dealt with, there would not have been many whole swords left in the army." But, after their miserably unsuccessful attempt to take San Domingo, Penn and Venables, joint commanders unfaithful alike to Cromwell and to each other, were fortunate enough to find in Jamaica a cowardly lot of Spaniards, who gave up their island home without striking a blow, not, however, before they had cheated the invaders into letting them get away with what riches they possessed. And from that day to this, amidst all the vicissitudes and contests on sea and land in the West Indies between England and France and Spain, Jamaica has—thanks probably to Rodney—remained in the possession of the British Crown; and the history of the influence of the English on the African race during that period may be perhaps better studied in Jamaica than in any other island.

The time at disposal will only admit of the briefest abstract of the principal events in the history of the island. After a short period of military command, General d'Oyley was appointed Jamaica's first governor, in 1661.

The capital, which was first at Cagua (Port Royal), was, in 1664, removed to St. Jago de la Vega (Spanish Town), where, in that year, the first general representative assembly of the people met. In that year, too, a census of the population was taken, which amounted to 4,205; but by 1698 the number had risen to 47,365 souls, of whom 40,000 were black. In 1670, Jamaica was formerly ceded to England by the treaty of Madrid.

When Blome wrote in 1672 there were 70 sugar works, 60 indigo works and 60 cacao walks in the island.

On the 7th of June, 1692, Port Royal, then the finest town in the West Indies and one of the richest places in the world—by reason of the treasures brought in by the buccaneers, whose headquarters it was—was destroyed by an earthquake; which event led to the development of the town of Kingston. In 1694, the island was invaded by the French under Admiral Du Casse, but the invaders were driven back; and in 1702 poor Benbow died at Port Royal of wounds received in the engagement with Du Casse off Santa Marta: he lies buried in Kingston Church. In 1711, the western part of the island was visited by a severe storm; the parish of Westmoreland alone sustained damage to the extent of £700,000. In 1730, 1732, and 1734, there were difficulties with the Maroons*, the descendants of the negroes belonging to the Spaniards who had fled to the wilder inland parts of the island; but in 1738 a treaty of peace was entered into with them, and settlements were assigned to them in various parts of the island. In 1744, Savanna-la-Mar was totally destroyed by a storm and earthquake, and Port Royal, Kingston and Old Harbour suffered. In 1760, there was a formidable rebellion amongst the slaves in St. Mary, and about 600 were transported to the Bay of Honduras. The expedition which was sent in 1778 by Governor Dalling of Jamaica against San Juan de Nicaragua is memorable from the fact that Nelson, who was then in official residence at Port Royal, took part in it. The expedition suffered severely from malarial fever, and Nelson only escaped with his life. In 1782, Rodney achieved his great victory over De Grasse off Dominica, and thus saved Jamaica from possible capture. The Rodney memorial at Spanish Town testifies to Jamaica's gratitude to that great naval commander. In 1795-96 there was further trouble with the Maroons.

In 1807, in the abolition of the African slave trade, occurred the first alteration in the condition of slave labour, on which the prosperity of the West Indies had been built up. (At this time, one third of the imports of the United Kingdom came from the West Indies. Now they contribute less than a two hundredth part). About twenty years later, during the administration of the Duke of Manchester, the controversy began between the Imperial Government and the House of Assembly in connection with the measures proposed by the former for improving the condition of the slave population. In May, 1833, a law was passed by the Imperial Government which declared that from and after August, 1834, all slaves in the colonial possessions of Great Britain should be free for ever, subject to an intermediate state of six years apprenticeship; this, however, was shortened to four years, and on the 1st of August, 1838, the total abolition of slavery took place in Jamaica. The sum of £6,149,934 was awarded to Jamaica slave-holders in compensation for the manumission of their property, *i.e.*, upwards of a quarter of a million of slaves.

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* From the Spanish *Cimarron*, wild, unruly, literally living in the mountain-tops; from *cima*, a mountain-top.

In 1828, ten years before the abolition of slavery, the export of sugar was 101,575 hogsheads. In 1848, ten years after it, it had fallen to 42,212 hogsheads. In coffee the fall was much greater, from 22,216,780 lbs. in 1828 to 5,681,941 lbs. in 1848.

As an immediate result of the abolition of slavery, need was felt for more labourers, and in 1842, the first batch of Coolie immigrants arrived from India.

In 1845, a railway was opened from Kingston to Old Harbour, 23 miles distant.

In 1865, during the governorship of Mr. Eyre, the outbreak at Morant Bay occurred, when the Custos of St. Thomas-in-the-East, and eighteen other gentlemen, were killed. George William Gordon, a member of the House of Assembly, was tried by court-martial and hanged. But Governor Eyre was recalled; and in the following year, Crown government was organised by Sir John Peter Grant.

In 1868, the fruit trade with America, which has proved such a boon to the island in recent years, was started: and in the following year, by the opening of telegraphic communication between Jamaica and Havanna, it first became possible to send telegrams from the island to Europe. In 1870, the Episcopal Church was disestablished, and the seat of Government was removed from Spanish Town to Kingston,

In 1891, an exhibition was held in Kingston, which did something towards enlightening the peasant population of the island about other countries, especially Canada, and towards stirring them up to take an interest in their own island; as well as bringing Jamaica more prominently to the notice of American and Canadian travellers. At most international exhibitions, the sections of the countries holding them exceed the foreign sections both in size and importance. This was, unfortunately, not the case in Jamaica; but a purely agricultural country like Jamaica is naturally at a disadvantage on such occasions, when compared with countries rich in arts and manufactures.

Last year, the railway was extended to Montego Bay, a distance of 113 miles from Kingston, and the branch to Port Antonio is now approaching completion. Thirty years ago it took two days, and cost about £10 to drive from Kingston to Montego Bay. To-day, one can travel in a comfortable third-class carriage, and get there in 5½ hours, at a cost of 5s.

It may be interesting here to call to mind some of the men known in literature, science or art, who have visited and resided in Jamaica from time to time, and who have had more or less effect on its social life.

The "Jamaica Viewed" (1661) of the Rev. Edmund Hickeringill, a somewhat remarkable man, by turns an army chaplain, a quaker, a deist, a naval captain, and, lastly, a rector, contains a map which is probably the oldest English map of the island. Dr. Henry Stubbe, the second keeper of the Bodleian Library, was, at the Restoration, ejected from office; but he nevertheless received, in 1662, the appointment of physician to the island of Jamaica, where he remained till 1665. Richard Blome, a bookmaker of considerable industry, but of small honesty, published in 1672 a Description of the island which he never visited; his work being based chiefly on the writings of Sir Thomas Lynch, the then governor. Its chief attraction is its map.

Sir Hans Sloane, the celebrated founder of the British Museum, went in 1687 in the suite of the Duke of Albemarle, to Jamaica, where, in fifteen months he collected 800 plants, most of which were new species. Of these he published, in 1696, a catalogue in Latin, and in 1707 and 1725 he published two large volumes, entitled "A Voyage to the Islands Madera, Barbados, Nievis, St. Christophers and Jamaica, with the Natural History of * * * the last of those Islands," with many engravings from crayon drawings. His Jamaica plants, &c., are now with the rest of his collections in the British Museum, the basis of which they formed. His work on Jamaica was satirised by that Dr. William King, of whom Lord Burlington has said that he could "write verses in a tavern, three hours after he could not speak." Smollett, the novelist, lived for a time (1741-44) in Jamaica, and married a lady owning property there. Patrick Browne's "Civil and Natural History" (1756), dealing almost entirely with natural history, was the result of several years' study of the geology, botany and zoology of the island.

Peter Pindar was for a time the incumbent of a living in Vere. William Beckford, the cousin of his namesake, the celebrated author of "Vathek," was a member of one of the wealthiest and most talented families which have ever been connected with the island. He spent thirteen years (between 1773 and 1788) on his various estates. His "Descriptive Account" (1790) was dated from the Fleet prison, a strange residence for one who could claim kinship with the owner of Fonthill. He was brought thither by misfortune, by imprudence and by the betrayal of trust on the part of a so-called friend. Beckford employed in Jamaica an artist, George Robertson, who made a series of good views of the island, engravings of which were published by Boydell, and also Philip Wickstead, a portrait painter, a pupil of Zoffany.

Edward Long, the historian of the island 1774), was a great grandson of the patriot, Samuel Long, who, going out as a lieutenant in d'Oyley's regiment, rose to be Speaker of the House of Assembly and Chief Justice, and who was sent home under arrest.

Bryan Edwards, the well-known historian of the West Indies, went in his youth to Jamaica, where he resided (with an interval from 1782 to 1787) till 1792, when he settled permanently in England as a West India merchant. His history (1793)—which ran through five editions, and was translated in part into German, Spanish, French and Dutch—was written at Bryan Castle, an estate which he founded in Trelawney.

Dr. William Wright, after serving as a naval surgeon under Rodney, lived for 16 years —between 1764 and 1785—in Jamaica, and wrote on Jamaica medical and botanical subjects, and furnished ornithological and entomological specimens for the museum of natural history of the University of Edinburgh, and botanical specimens to Kew and Sir Joseph Banks's collection.

Early in the year 1783, the House of Assembly voted £1,000 for a statue of Rodney in commemoration of his victory over De Grasse. As is not unusual in such cases, it cost considerably more, £5,200 in fact, before it was erected; and to this they added £3,000 for a building to hold it. The choice of the sculptor was left to the Royal Academy, who chose Bacon, and Barry has told us that Reynolds was much disappointed at the poor result. It is interesting to note that the execution of this work led to Bacon's receiving five other commissions for memorial statues in Jamaica.

John Hunter, who is not to be confounded with his more celebrated contemporaneous namesake, was from 1781 to 1783 superintendent of the military hospitals in Jamaica. His "Observations on the Diseases of the Army in Jamaica" (1788) forms an important contribution to the island's medical literature.

Dr. Thomas Dancer, who lived in Jamaica from 1773 till his death in 1811-12, was chief of the hospital staff on the expedition to San Juan de Nicaragua. He is best known by his "Medical Assistant" (1801).

Robert Charles Dallas, the author of the "History of the Maroons" (1803), was a member of an old Jamaica family. A most prolific writer, he is chiefly remembered in England by his literary connection with Byron, with whom he was connected by marriage.

William James, the author of the "Naval History," practised as a proctor in the Vice-Admiralty Court from 1801 to 1803.

Michael Scott's popular works, "Tom Cringle's Log" (1833) and "The Cruise of the Midge" (1834), originally published in "Blackwood," were written in Jamaica, where Scott was engaged in agricultural and mercantile pursuits. Tom Cringle's cotton trees, at the camp near Kingston and on the Spanish Town road, are still standing. For a true picture of Jamaica scenery and of Jamaica life in the early years of the century, no writings can compare with these two works.

But of all the men of letters who have been connected with Jamaica from time to time, perhaps the most noted is "Monk" Lewis, famous in his day as novelist, dramatist, poet and song-writer. He owned properties in Jamaica, and, though he only spent a few months in the island, which he visited in 1815 and 1817, he displayed great sympathy for the negro population under his control, and did much for their welfare—a marked contrast to to that other literary Jamaica proprietor, "Vathek" Beckford, who did nothing. His "Journal of a West India Proprietor" was not published till 1834.

Sir Henry Thomas De la Beche, the eminent geologist, visited his estate of Halse-hall in 1824, and contributed to the social history and geological literature of the island.

James Hakewill, an architect by education and profession, who was one of the competitors for the new Houses of Parliament, is chiefly known for his "Picturesque Tours" of Italy and Jamaica (1825). Of the illustrated books on the island, the latter is certainly the most artistic.

The Rev. George Wilson Bridges, the author of the "Annals of Jamaica" (1828), was an island rector whose sympathies were rather with slave-holders than slaves, and often led him into conflict with the dissenters.

Dr. Richard Robert Madden, the writer and philanthropist, and friend of Lady Blessington, went out in 1833 as one of the six special stipendiary magistrates appointed to administer the statute abolishing slavery in the plantations. His zeal on behalf of the negroes embroiled him with the planters; he resigned after a year's labours, and thus Jamaica lost one who might have been of great service to her for many years. During his term of office four of the special magistrates died, and four, including himself, resigned—so arduous were their duties.

In 1837, appeared an important contribution to the botanical literature of the island in James Macfadyen's "Flora of Jamaica." Three years later, Joseph B. Kidd, a member of the Scottish Academy, published his "Illustrations of Jamaica," a larger and much more pretentious volume than Hakewill's: its subscription price was £20.

Philip Henry Gosse, the well-known zoologist, visited Jamaica in 1844, where he remained for eighteen months, and collected and sent home specimens of many rare animals. In 1847 he published his "Birds of Jamaica," and, two years later, a folio volume of plates in illustration. In 1851 he published his "Naturalist's Sojourn in Jamaica," in which he was much assisted by the Hon. Richard Hill, one of Jamaica's most talented sons. In his scientific work, Hill corresponded with Darwin, and through his philanthropic labours he became acquainted with Wilberforce, Buxton and Clarkson.

Though upwards of a quarter of a century old, the "Reports" (1869) of James G. Sawkins, forming Part II. of the "West India Survey," still remain the standard work on the geology of the island; and his collection of minerals is in the museum of the Institute of Jamaica. In 1871-72, Miss North stayed five months in Jamaica, and made drawings of many plants and flowers, 46 of which are now in the gallery containing her collection at Kew.

So far as societies devoted to the interests of literature, science and the arts are concerned, Jamaica, considering its size, has had a very fair proportion; the unfortunate feature of the case being, however, that so many of them have died after only a few years' existence, leaving the work of commencing *de novo* to the next generation. The first record to be found of any agricultural society in Jamaica occurs in 1807. The society in question, which belonged to the county of Cornwall, was called The Agricultural Society, so it was presumably the only one of the kind in the island. In 1825 was founded, at Kingston, a Jamaica Horticultural Society, which, two years later, became the "Jamaica Society for the Cultivation of Agriculture and other Sciences." By 1843, there were local agricultural societies in twelve of the parishes, due, in great measure, to the interest which Lord Elgin, the Governor (afterwards better known as Viceroy of India), took in agricultural affairs. In the same year was founded a general Agricultural Society, which, in 1845, became the Royal Agricultural Society of Jamaica, with the Queen as patron; and for many years this societ and the old Jamaica Society for the Cultivation of Agriculture, were working on similar lines. In 1845, also, the local agricultural societies had reached sixteen in number. In 1854, a Jamaica Society of Arts was established. Two years later it became the "Royal Society of Arts of Jamaica," and in 1864 it was amalgamated with the Royal Agricultural Society of Jamaica, and became the Royal Society of Arts and Agriculture; but this last society existed for less than a decade, and its collections passed into the possession of the Institute of Jamaica, which was founded by Sir Anthony Musgrave in 1879, for the encouragement of literature, science and art, and which, in addition to providing a public library, a museum of natural history, and a small art gallery, aims at doing in Jamaica what the Society of Arts does in England.

There have been many literary societies formed at one time or another in Kingston and other towns. One of Jamaica's candid friends, writing in 1808, said, "Literature is little cultivated in Jamaica, nor is reading a very general favourite amusement," and he goes on to complain that people chiefly read ephemeral novels. Though reading can hardly yet be called "a very general favourite amusement" in the island, it is taking a hold of the people of Kingston, and there are evidences that it is spreading throughout the country districts, and in this movement the press of the island is playing no small part.

In 1794, a Kingston Medical Society was formed, but by 1832 it was defunct: to be succeeded in 1877 by a branch of the British Medical Association.

The lesson that one learns from the history of the many societies which have existed in Jamaica during the present century, is that voluntary societies founded at moments of temporary enthusiasm were dependent in great measure on the activity and pecuniary and moral support of a few prominent individuals;

and that so soon as the support and motive power were lost, the societies declined.

The Agricultural Society, which has been inaugurated this year, under the presidency of the Governor, mainly with a view of aiding the small settlers to improve their position, has, it is to be hoped, a foundation in happier times, and the awakening of the people to the need of invoking the aid of science in the pursuit of agriculture, augurs long life and prosperity to the society.

With the advent of the new society, the older Society of Agriculture and Commerce (founded in 1885) has stirred itself up to new activity. History repeats itself; and the year 1895, like the year 1845, sees two societies in Jamaica working in the chief town in the cause of agriculture.

III.—GOVERNMENT AND LAWS.

When the colonisation of the newly-acquired island of Jamaica was organised in 1661, the first thing the Governor was directed to do was to "take unto him a Council of twelve persons, to advise and assist him in the execution of his trust." Authorities differ as to whether this Council was chosen by the Governor or elected by the people, but it formed, at all events, the prototype of the present Privy Council of the island under whose advice the Governor now governs.

Lord Windsor, the second Governor, was directed to call, with the advice of his Council, assemblies to make laws, such laws to be in use for two years only unless approved by the Crown. Not many years passed, however, before an attempt was made to force upon the island the form of legislation prescribed for Ireland by Poyning's law. The virtual difference between the two systems being that in the one the island made its own laws in accordance with its own needs and sent them home for approval, and in the other the laws were made in England and sent out for the approval of the island. The proposed change, the Assembly resisted with might and main; their late Speaker, the Chief Justice of the island, being sent home a State prisoner. But success crowned their efforts. In 1728 an agreement was entered into by the Ministry of George II., by which, in return for an annual subsidy granted to the king for the support of the civil government, full power of legislation was conceded to the governor with the advice and consent of the Legislative Council and House of Assembly of the island, subject only to the proviso that any Acts passed should no be repugnant to the laws of England, and to disallowance within a limited period by the Crown. After this, for nearly a century and a half—until, in fact, the members of the Assembly in 1865, after the disturbance in St. Thomas-in-the-East, surrendered the privileges for which their forefathers had struggled—the people of the island of Jamaica enjoyed, with certain modifications introduced from time to time, the right of making their own laws, subject only to the provisoes abovementioned.

In 1865, a system of government by a Governor assisted by a Legislative Council consisting of *ex-officio* and nominated members, commonly called Crown Government, was introduced, under which the Governor was armed with almost despotic power in the island, subject only to Home control. Under this form of government many eminently useful reforms, both administrative and legal, were introduced. But, in 1884, matters came to a deadlock, owing to the general resignation of the unofficial members, and the unwillingness of any private person to accept the position of a nominated member. Accordingly, a change was made by which members elected by the people were substituted for members nominated by the Crown, and the Council then became composed of three *ex-officio*, four nominated officials, and nine elected members, with the Governor as president. So that only for about nineteen years in its history, have the people of Jamaica been without a share in the legislation of the island; and during this year the number of elected members has been increased from nine to fourteen, *i.e.*, one for each parish of the island, the number of nominated official members being at the same proportionately increased.

The laws of Jamaica respecting marriage, land, industry, &c., differ in no appreciable degree from those of England. As they now stand, they are the common law of England as modified by British legislation prior to the conquest, and by such Acts of Parliament passed between that time and 1815 as were during that interval recognised and acted on by the Courts, and by such Acts of the local Legislature, whether passed before or since 1815, as have not been disallowed by the Crown. On the whole it may be said that English law prevails (at least in its main features) in the island. Though English Acts of Parliament passed since 1728 have not, of themselves, the force of law in the island, yet a large proportion of those suitable to the condition and circumstances of the place have been adopted, with or without modification, by the local Legislature. These, together with numerous laws of a local or administrative character passed by the Governor and Council, constitute the "Acts and Laws of Jamaica."

There is a system of poor relief, the funds being derived from a tax on houses; and the administration is vested in the parochial Boards, subject to a body called the Board of Supervision, instituted on the Scotch model.

IV.—EFFECT OF BRITISH INFLUENCE ON THE NEGRO POPULATION.

As the Spaniards killed off the aborigines, we must look upon the African negroes imported into the island and their descendants as the natives of Jamaica.

It has been estimated that upwards of 1,000,000 Africans were imported against their wills into Jamaica during the entire period of British rule; and this, of course, does not include the very large number which were yearly born into slavery.

Till the close of the last century, it was the almost universal custom to regard slaves as little better than cattle, and the old newspapers contain, side by side, advertisements for lost cattle and runaway slaves.

Amongst the many conflicting accounts of life on the old estates, it is difficult to arrive at the truth. But it seems evident that on some few estates, at all events, the treatment of slaves was brutal in the extreme, for which brutality the absentee proprietors were in a great measure answerable, for many of them, leaving their properties in the care of attorneys, cared not how the slaves were ill-used so long as the estates produced good incomes. On the other hand it is certain, that on many estates the slaves were treated with care, not merely because of their money value, but because their owners were humane—although those same owners would have scoffed at the idea that there was anything wrong in their holding a brother man in bondage.

When emancipation came—although the ministers of religion had done much towards preparing their minds, and some over-zealous well-wishers had, it may be thought by some, gone almost too far in the direction of preaching equality—the negroes were not thoroughly prepared for it. No man would now, of course, defend slavery or would wish to delay emancipation for one moment; but no one, on the other haud, would advocat turning a number of half-educated and but half grown-up school-children into the world to fight the battle of life for themselves; and the negroes of Jamaica, at the time of emancipation, were in many respects little better equipped than children for life's battle.

Since that date, however, their needs and wants have been carefully considered by the Government and the Legislature; and ministers of religion of all denominations and others, aided by philanthropic and religious societies at home, have done all in their power for the amelioration of the race.

England, during two centuries of occupation in the West Indies, incurred, by reason of her participation in the slave trade and slavery generally, a deep obligation to the negroes of Africa. This debt she is now endeavouring to repay by doing her utmost to advance the interests of the race. It must of necessity be a somewhat lengthy process; but it would seem that a negro peasant population is growing up in Jamaica, which will, it is to be hoped, in a generation or two, prove a mainstay and support to the industries of the island.

Those who are disappointed in the Jamaica peasant of to-day are, I venture to think, unreasonable. They expect too much of him. When we consider that but two generations ago the negro was treated like an ox, driven too often to his work at the whip's point, and purposely kept from all advance either in morals or education, it is a matter for surprise that he is to-day so far advanced as he is. In many cases, a field negro will not work for his employer more than four days a week. He may till his own plot of ground on one of the other days or not as the spirit moves him; but four days' work a week will keep him easily. He has little or no care for the future. There has been no biting frost of last winter to make him think of saving up against hard times. If by chance he is out of employment (and it is probably his own doing if he is) his needs are few. He has possibly squatted on someone's land, and rent he has none to pay. Clothes he need scarcely buy; fuel he wants only for cooking purposes, and food is ready to his hand for the picking. If under these conditions the negro is apt to be indolent and improvident who shall wonder?

Times of disaster, due in most instances to drought, do occur now and again, and generally find the negroes without any savings to draw upon; but poverty as it too frequently occurs in crowded centres in England, made all the more bitter by severe cold, is absolutely unknown in Jamaica.

The small accounts in the Government savings' banks are increasing year by year, showing that habits of thrift are being inculcated into the minds of a race by nature thriftless; but it may be noted that though the coolies form less than 1-60th of the population, they formed during the year 1894-95 about 1-27th of the depositors in the bank.

In the old days, one of the chief festivities of the negroes was that of "John Canoe," a pageant, brought from Africa, which took place at Christmastide. It is said that as much as £15 used to be given for a single costume. Like the Morris dancers and mummers of Europe, these festivities have almost fallen into disuse; and the main object of pleasure-seekers, described by "Monk" Lewis as consisting in "singing, dancing, and laughing, in seeing and being seen, in showing their own fine clothes or in admiring those of others," now finds expression in picnics and such-like gatherings. Their disuse may be attributed in part to the negro's fear of ridicule; and partly, too, to the same cause may be ascribed the less frequent use in later years of their proverbs and sayings, many of which are very expressive and full of humour.

That superstition is still prevalent amongst the negroes is unfortunately evidenced by the cases of obeah, or witchcraft, that come before the Courts from time to time, and by the springing up of prophets of the Bedward type—a man who professed to cure all human ills by blessing the waters of a stream near Kingston, and who had for a time a very large following. All one can say is that superstition is not unknown elsewhere. That distrust of those in authority has not been quite eradicated from the negro mind was proved in 1891, when negroes coming from the distant parts, on seeing turnstiles at the Exhibition entrance, declined to enter, thinking the Exhibition had been erected to entrap them into slavery. And this year some of the peasants have hesitated to bring their horses and other stock for sale at the local fairs, which have been instituted in order to provide them with a more ready sale, fearing that it was intended to find out how much stock they possessed, with a view to increased taxation. But cases such as these are fortunately becoming less frequent.

Looking down the long years of Jamaica's history, and viewing its position on the map, one is surprised to find the thought as well as the life of the people so thoroughly English as it is. Spain has left behind her little trace of her occupation. The neighbouring French islands have had absolutely no effect whatever. The vicinity of Central and South America have had no influence. Although Americans from the United States own the railway and run it on the American system, are in possession of much of the fruit trade, and are large employers of labour, and although English news is daily telegraphed to the island through an American medium, and the almighty dollar passes current, yet American influences have not affected the life or thought of the people. The very large number of inhabitants of African origin have all been moulded by English thought in a manner in which neither Chinese nor Indians could have been moulded; and this plasticity is very evident in the extraordinary manner in which those of African origin in Jamaica have discarded and forgotten the language of their fathers.

Jamaica's language, religion, laws and politics are English, and her people are English in feeling, and this feeling is being strengthened day by day by the schools, the churches and the press. News from London, the great centre of the empire, is eagerly read and appreciated, the Union Jack is honoured, the Queen is beloved, and nowhere in the British Empire would that closer union—which has been alluded to more than once of late by the Secretary of State for the Colonies, and a possible first step towards which has already been taken—be more cordially welcomed than in the leading colony of the British West Indies. But a preparatory step towards such a union would be the closer federation of the West India Islands themselves. If one was not aware of the difficulty and expense of intercolonial communication, and of the fact that West Indians, when they take a holiday, go to England, or, in some cases, to the United States, it would seem strange that a collection of British islands—separated the one from the others by distances not great in comparison with their distances from other British possessions, and with many conditions of life in common—should not have, in the long course of their British colonial history, been drawn more closely together than they are, especially as in certain times—such as in the case of their resistance to the abolition of slavery—they have been impelled to act in concert.

A Jamaican sees more of his brethren o

the other islands in six months spent in London and on shipboard between Barbados and Southampton, than in six years in his own island.

V.—Agriculture, Trade and Commerce.

The chief occupations of agriculturists are pen-keeping, *i.e.*, the breeding of horses, mules, cattle and sheep; sugar-planting, coffer-planting, banana cultivation, and the growing of cocoa, cocoa-nuts, ginger, limes, logwood, nutmegs, oranges, pimento and tobacco, the last-named being however, almost entirely confined to settlers from Cuba.

The cultivation of indigo, which was formerly a staple product, has long since been abandoned.

Ramie, or China-grass, grows freely, and only awaits the advent of a suitable machine for treating it, to become a thriving industry, as is also the case with various other fibre-bearing plants.

It has been recently pointed out that there is an abundance of land suitable for growing vegetables near Spanish Town and Kingston on the south, and near Port Antonio on the north-east coast, whence frequent shipments could be made to New York, Boston, Baltimore and Philadelphia.

A certain Henry Whistler, who went out with Penn and Venables, wrote of the island, "The Spaniard doth call it the garden of Indies, but this I will say, the gardeners have been very bad, for here is a very little more than that which groweth naturally." Although that remark is not true to-day of the whole island, yet it might be fairly applied to certain cases.

It was Sir Anthony Musgrave in 1877-1882, who, in addition to the reorganisation and development of many official institutions, the establishment of a steam coastal service, and the extension of the railway, insisted on the importance of devoting attention to the so-called minor products of the islands, and Jamaica is to-day reaping the benefit of his policy. If all her eggs had remained in the sugar-basket, she would now be in the same unfortunate position as are some of her sister islands in the Caribbean Sea, which are entirely dependent on the sugar-cane.

In his paper entitled "A Tropical Colony" in the "New Review" for September, Mr. Frederick Boyle says, "The West Indies are ruined to a proverb," and possibly many in England are of his way of thinking. But a study of the imports and exports for the last few years, to say nothing of a knowledge of the natural resources of the island and the steady advance in matters educational which has recently taken place, certainly leads one to suppose that Jamaica is to-day further removed from ruin than it has been since its so-called palmy days a century ago.

In 1845, the revenue of the island was £276,045, and the expenditure, £273,199. In 1893-94, the revenue—which is derived from import duties and excise, from taxes on land, horse kind, carriages, by education and poor rates, the export duties having been abolished in 1891-92—amounted to £757,649, and the total expenditure to £750,906.

The Public Debt is now £1,672,299.

Imports.—The following is a summary of the totals of the different groups of articles entered for home consumption in 1894-95, compared with 1893-94:—

	1894-95 £	1893-94 £
Articles of food, drink and narcotics	845,079	825,952
Raw material	67,432	49,680
Manufactured articles	1,249,676	1,219,405
Coin and bullion	28,525	41,076
	2,190,712	2,136,113

The value of the imports for 1894-95 (£2,191,745) is higher than any of the preceding ten years, the next highest being 1890-91, which was abnormally increased by reason of the Exhibition held in that year. Of the imports of 1894-95, 50·4 per cent. was drawn from the United Kingdom, as against 55·1 in 1893-94; 36·8 from the United States, as against 33·3; 8.5 from Canada, as against 8·8; 4·3 from other counties, as against 2·9. This shows an increase in favour of the United States over previous years, due to a large increase in the imports of food stuffs.

The Collector-General points out that an increase in the number of cattle (£19,105 worth in 1894-95) horses and mules (£6,658), and sheep imported, as well as forage, suggest that something is amiss in the management of the pens, or stock farms: and, following the same line of thought, one wonders why Jamaica should in one year import fish to the value of £186,652 while there is a large supply of wholesome food-fishes in the water around the coast, or pay £31,599 a year for pork and £38,143 for butter, when pigs are easily raised and butter easily made. Upwards of £62,971 a year, too, is paid for lumber, and, in the present condition of the labour market, it is cheaper for a planter to import American pine and pay the freight in the island to his estate than to pay for the labour of cutting down and sawing up a better tree on his own property. An answer to all this may probably in part be found in the difficulty often experienced in obtaining either skilled or trustworthy labour.

Exports.—The value of the exports for 1894-95 (£1,921,421) is the highest for the last ten years, except that for the year immediately preceding (£2,075,689).

The following is a comparative statement of the proportion of exports during the last three years:—

	1894-95.	1893-94.		1892-93.	
Fruit	27·9		26·6		23·1
Sugar....12·9	23·0	14·2	21·6	14·3	25·6
Rum ....10·1		7·4		11·3	
Coffee	19·3		17·3		20·1
Dyewoods	19·0		24·3		21·1
Pimento	4·5		3·8		3·5
Minor products.	6·3		6·4		6·6
	100·0		100·0		100·0

As will be seen from the above table, in 1893-94, the products of the fruit plantations (principally bananas) for the first time deposed the products of the sugar estates (sugar and rum) from the premier position which they had ever held in the exports of the island. Of sugar less than 6 per cent. of the whole export comes to England and nearly 90 per cent. goes to America; while of rum, the States receive but 1·6 per cent., and the United Kingdom over 90 per cent.

Comparing the present with the past, we find that the largest amount of sugar exported in any one year was 150,352 hogsheads, in 1805, while the largest export of rum was in 1806 with 58,780 puncheons (4,232,160 gallons), as against 1,956,291 gallons exported in 1894-95. But it must be borne in mind that at the beginning of the century all the sugar and rum consumed in England came from the West Indies. There was no competition from Mauritius, Queensland, Natal, Borneo, Peru or Egypt, and last, but not least, no unfair competition from the very inferior bounty-fed beet sugar of Europe.

During 1894-95, the exports were distributed in the following manner:—to the United Kingdom, 27·1 per cent. as against 26·7 in 1893-94; United States, 58·1 as against 57·3; Canada, 1·5 as against 1·7; other countries, 13·3 as against 14·3.

Cane Cutters.

The changes here are unimportant, England and the United States gaining slightly at the expense of the other countries.

The large proportion of exports taken by the United States is due in great measure to the banana trade, which has sprung up of late years, and which has also indirectly proved an agent in bringing visitors to the island.

The bananas exported in one year exceeded £500,000 in value. Of these nearly the whole go to the United States, but, large as this amount is, only a small per-centage of the fruit produced is shipped. In connection with this trade, the question arises as to the disposal of the fruit which, from its smallness and other causes, cannot be shipped. Bananas can be converted into yeast and alcohol, and, above all, meal, which is highly nutritious in character. Proposals have been made for the establishment on a large scale of a banana flour factory in the island; the price offered, however, by the proposers, for the bananas being apparently too low to encourage planters to entertain the project.

That experiments in the shipping of fruit to England have not hitherto proved altogether satisfactory, is in great measure due to the fact that ships built for passenger and ordinary freight traffic are not suitable for the conveyance of perishable fruit.

With a line of fast fruit-bearing steamers between Jamaica and England, which may possibly be accomplished by private enterprise in the near future, and with a recognition on the part of the British public of the highly nutritious qualities of the banana, there should be no reason why as large a quantity should not be sent to England as now goes to the United States.

Moy Hall Coffee Estate, in the Blue Mountains.

In spite of the somewhat gloomy outlook for the proprietors of sugar estates, who are, however, in no worse a plight than the hop-growers of Kent or the wheat growers of England generally—there seems to be a true revival of prosperity setting in for Jamaica. Even in the case of the sugar estates, the past crop was good, and the prospects of that now being reaped are favourable. Future prosperity for these estates possibly depends on more advanced cultivation, and on the abolition, by the countries that now grant them, of the bounties on beet sugar, not as a result of remonstrances by Great Britain, but because they will probably become intolerable; rather than on countervailing duties imposed by Great Britain, which would seem to involve a revision of England's free trade policy. But it is to be hoped that in any future legislation on matters agricultural, the West Indian sugar-planter will not be forgotten. Central factories are by many considered the panacea for the sugar-planter's ills, and they are now being fully discussed in the island; but there will not impossibly be found difficulties in the case of Jamaica which do not exist to such a large extent in other sugar-producing countries.

Coffee and dye-woods, two of the principal exports, seem destined to be a permanent source of income, in spite of the present decrease in consumption of the former, and the slight decrease in the export of the latter; while at present, at all events, there are but few signs of abatement in the popularity of the banana in America.

Oranges, which ever since the Spaniards introduced them have grown freely in the island, have been receiving more attention of late years, with a view to their better cultivation, selection and packing for export; and the severe frosts experienced in Florida last winter directed the attention of numerous Florida orange-growers to Jamaica, some of whom have already started operations in the island, and one company alone has during this season shipped from 1,500 to 2,000 boxes a week to New York.

It would seem that a combination of the advanced culture of Florida based on considerable experience, and care in picking, selecting and packing, with the more equable climate of Jamaica, should give good results.

The extension of the railway to Montego Bay and to Port Antonio, the latter the chief port of shipment of fruit to America, with the constant addition to the already excellent roads of the country and the bridging of rivers which have hitherto been impassable in the rainy seasons, cannot fail to give a great impetus to trade and commerce in the island; and the improvement in shops—or stores, as they are there called—which has taken place during the last few years, both in Kingston and the smaller towns, points to commercial activity and prosperity.

VI.—Colonists and Colonisation.

In a country of the hilly nature of Jamaica, there are, of course, parts—Jamaica's hinterland—which would scarcely repay cultivation: apart from such tracts, there are, however, large areas of land waiting for cultivation.

Of Crown lands there are nearly 50,000 acres unoccupied; part is, owing to its inaccessibility, of no great value, but much is suitable for occupation. About 26,000 acres of Crown land are leased to some 600 tenants, and 36,850 acres are unpatented.

A scheme has been prepared for the sale of Crown lands in small lots of from five to fifty acres, at a price of 5s. per acre and upwards, on deferred payments, which should prove a boon to small settlers, and should act as a deterrent to that nomadic squatting life hitherto adopted by the negroes, which is so inimical to true agriculture.

Under the railway law, a square mile of land is assigned to the railway company for every mile of line taken over; and this land, which will exceed 100 square miles, will be available for settlers.

In connection with the suitability of a country in the tropics for colonisation one of the first questions to be considered is, of course, whether a European is able to do manual labour there. In the paper by Mr. Frederick Boyle, to which I have already referred, the writer—who claims that few men have had so varied an experience of hot countries as he has had—expresses his conviction that man the animal, like all other living things, attains his highest development in the tropics; and he repeats the saying that Irish navvies imported made the Panama railway, when peons, West Indian negroes, and Chinamen had all been tried, and all collapsed successively. Certain it is that the evil reputation acquired by the West India Islands in the past, from an hygienic point of view, and which they still retain in the minds of some people, is due, in great measure, to culpable negligence of the laws of health on the part of emigrants. In the old days in Jamaica, the soldiers were stationed, in insanitary barracks, in most unhealthy localities, and naturally succumbed. Young men who went out from England to sugar estates, were wont to indulge in drink and other excesses, and to expose themselves to the heat of the sun and to the night air, with fatal results.

Except near lagoons and morasses, the island is healthy. The heat is at times oppressive, but rather on account of its continuance than of the height of the thermometer. In the higher lands the heat is bearable even on the hottest day, and even in the lowlands it is not so hot as in corresponding latitudes in the eastern hemisphere. The mean daily temperature for 1893 was 76·5 An analysis of ten years' record gives a mean range of 17·1. Since June, 1880, the highest temperature recorded was 96·7°, and the lowest 56·7°. Jamaica possesses a happy immunity from sunstroke; and many complaints common in Europe are but rarely met with there. It is true that of late years the influenza has visited the island, but the cases have not been so severe, nor has the mortality been nearly so great as in England. To some weak constitutions, especially those whose respiratory organs are delicate, the climate is far more suitable than that of England with its violent changes from heat to cold. To sum up in brief the qualifications of Jamaica's climate, I may quote one sentence from an article on the subject by Dr. Stedman of New York, an independent witness, who says, "When proper sanitary precautions are taken, and due care is paid to personal hygiene, whether among military men or among civilians, the climate of Jamacia is as healthy as that of any part of the world. Admitting the possibility of contracting, through carelessness or otherwise, some tropical fever, this possibility is more than counter-balanced by the immunity from other sicknesses and ailments which have their origin, not in evil conditions and surroundings which man can remedy, but in the cold of winter, in frost and ice, and snow and blizzard, against which there is for the delicate constitution no escape but flight."

Jamaica possesses a very great variety of climate, due in great measure to the differences of altitude. A ride of three or four hours will take one from the plains of Liguanea, where one would be glad of a punkah, to a house in the Blue Mountains some 4,000 feet high, where a fire is not unacceptable; and one passes on the way, of course, a succession of intermediate temperates. One can walk miles in the hills with enjoyment, while in the plains such a form of exercise becomes rather a duty than a pleasure.

Nearly one half of the area of the whole island is above 1,000 feet in height and temperate in climate. The rainfall varies very much throughout the island. For the whole island, the annual average is 66·3 inches; at Kingston it is 32·6; and at Cinchona, in the Blue Mountains, it is 105·57. No month is, as a rule, quite without rain, but the heavy rains come in May and October, the latter being the heavier and lasting the longer. About a century ago, Jamaica suffered much from hurricanes, which destroyed buildings and crops. But they fortunately seldom visit the island now-a-days. They pass north and east, and also to the south and west, with comparative frequency, but they seldom hit the island itself.

The question of the amount of manual labour that a European can do in the tropics is one difficult to answer, for men differ greatly in constitution—both physically and mentally. When necessary precautions are taken against exposure to the sun and the night air, and due regard is paid to diet, there is no reason why an Englishman should not keep his health in many parts of Jamaica, doing a fair amount of almost manual labour. To give but one example, many medical men in the island work quite as hard as they would in England, riding long distances along hill paths at any hour of the day or night.

Mr. Boyle says truly, "A man will keep his health and spirits when he is tilling his own land under conditions which would prostrate him if he were toiling for another." And certainly many British-born planters and pen-keepers in Jamaica, in their work of supervision, do a very large amount of labour without suffering ill effects.

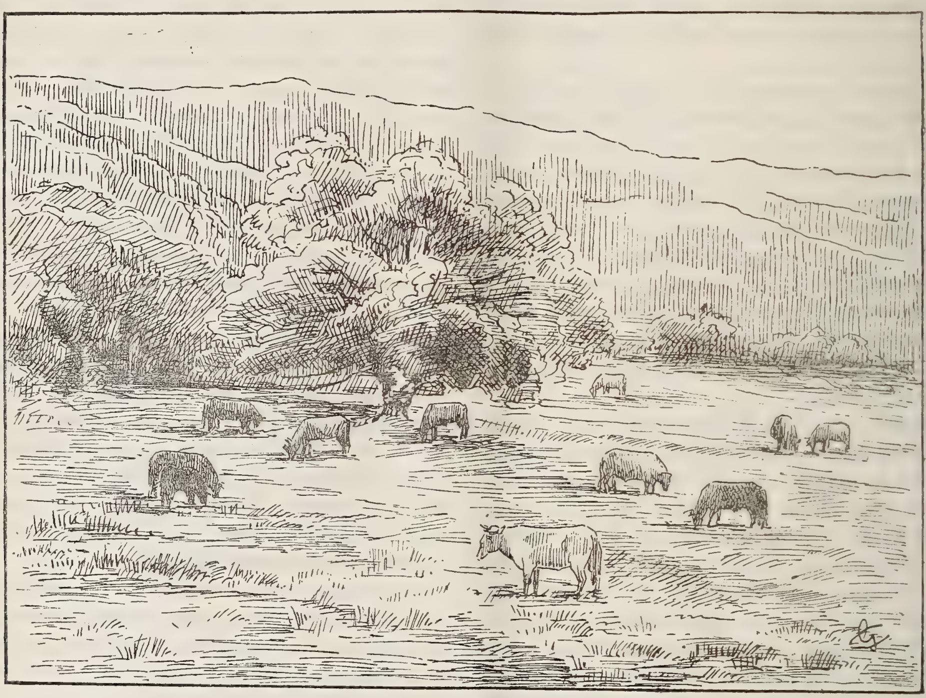
Jamaica undoubtedly offers numerous favourable openings for young men from Great Britain and other European countries, with small capitals (say of from £2,000 to £3,000) and some experience in farming, who wish to adopt an agricultural career. But, as many are deterred by the knowledge that to start farming or planting without some preliminary experience of the country and of the conditions under which agricultural pursuits are carried on, is to court disaster, the Governors of the Institute of Jamaica took steps in 1891 to bring about a means of communication between those planters and pen-keepers who are willing to receive young men as articled pupils, and intending emigrants from Great Britain and elsewhere. A register of such planters and pen-keepers as are willing to take pupils has been prepared; but it must be distinctly under stood that the Governors can accept no responsibility at all in the matter, and can only circulate copies of the *précis* of the replies received from planters, from which inquirers must draw their own deductions.

Pupils must also communicate direct with the planters and pen-keepers with respect to terms, &c., and it is suggested that some friend should if possible be asked to visit the property on behalf of the pupils.

A schedule, which has been compiled from the replies alluded to above, hitherto received from the planters and pen-keepers, shows (1) the nature of the properties, (2) the districts in which they are situated, (3) the premium required, (4) some indication of the kind of home and surroundings the pupil might expect, and (5) the work they would have to perform and the instruction they would receive. Copies of this schedule can be obtained on application to the Institute in Jamaica, or to the Emigrants' Information Office, at Westminster, with which the Institute of Jamaica is in correspondence.

With reference to the emigrant without means, one who has had eighteen years' experience of tropical colonies, both east and west, including Jamaica, and has had every means of judging of the conditions under which agricultural life is there carried on, tells me that he has never known a single instance where white men have been able to establish homes and live comfortably on the result of purely manual labour. And certainly the records of past attempts in that direction in Jamaica, as elsewhere in the West Indies, have been anything but encouraging.

The chief feature in Jamaica's favour would be that the agricultural settler's needs would be few, and that he would find himself living under the British flag. He would have knowledge and English perseverance and persistent work to put against the negro's spasmodic labour, disregard for the future, and present indifference to scientific methods; but, on the whole, the disadvantages would outweigh the advantages. If he went by himself, he would find himself isolated, without any of his class near him—a condition of affairs too often conducive to drink and inattention to business—for hitherto English settlers have, in the main, been either men with means, who have purchased estates, or young men who have been content to hold subordinate positions on estates until they have saved up enough capital to embark in planting for themselves. He would also find himself handicapped, from a constitutional point of view, when compared with the negro peasant, by whom he would be despised, for the negro has a contempt for white men who have to work like himself. With a capital of £2,000 to £3,000, as I have said, he would have a fair opening; even with one of some £400 or £500, he might have a chance of success.



A CATTLE PEN IN ST. ELIZABETH.

Although the country is almost purely agricultural there are of course settlers who arrive from time to time for work in the towns. So far as I know, all those who abstain from the curse of drink (and it has proved a sore temptation to many) have done very well. But they have come out as the result of previous arrangement with store-keepers and others in the island, or with their representatives in England. There is a dearth of skilled craftsmen, both for the construction and the repairing of objects; but the settler would probably have to make his own business connection, and would not readily find employment.

Clothing is slightly dearer than in England, but is readily obtainable in Kingston and elsewhere. Meat, fish, poultry, fruit and vegetables, are both plentiful and cheap. But those living in or near Kingston, and occupying an official position, find living more expensive than in England, by reason of the fact that some things, such as horses and carriages, which are a luxury in England, are almost a necessity in Jamaica. In the country, where pasture is plentiful and life is simpler, the cost is, if anything, less than that of England.

The manufactures of the island are but few. They include dye-works, recently established at Spanish Town, electric light, gas, and water-works, iron foundries, and railway works, printing offices, potteries, and ice and mineral water factories.

There is a Central Board of Health in Kingston, and the local boards of the parishes act as local boards of health.

The island is divided into forty-eight medical districts, to each of which is appointed by the Government a medical officer, who is held responsible for the due discharge of all medical duties within his district. There are few places in the island more than eight or ten miles from the residence of a medical officer, and, as there are good driving and riding roads, the distance is really not great.

There are twenty-three hospitals in the island; and two of the mineral springs of the island have bath-houses attached and provision is made for visitors—at Bath in St. Thomas-in-the-East, a sulphur spring; and at Milk River, a saline. They possess therapeutic properties of considerable value. The former was a century or more ago as fashionable in Jamaica as its namesake was in England.

Jamaica entered the postal union in 1877, and it now possesses all the chief postal and telegraph facilities, both foreign and inland, enjoyed in European countries. A letter can be sent to any part of the island for one penny, but there is a house-to-house delivery in Kingston only, letters and parcels in other places having to be fetched from the nearest post-office.

There are 102 constabulary stations in the island, and a force of 776 men. The inspectors are chiefly Englishmen.

There are about 628 churches and chapels for religious worship, the chief of which belong to the Church of England, the Baptists, the Wesleyans, the Presbyterians, the Roman Catholics and the Moravians; and these and other religious denominations have maintained for years a large number of schools, and have done in the past, as they are doing in the present, a very great deal for the advancement, both social and intellectual, of the native population of the island.

The principal denominations are represented on the Board of Education, and although Jamaica is not quite free from denominational disputes, the various ministers of religion work together for the common weal.

The elementary schools, attendance at which is voluntary, in 1894 numbered 962, with 104,149 scholars on the books, and 62,587 (or nearly 1 in 11 of the population) in average attendance; at a cost of 17s. 3d. a head. (In the Board schools of England, the cost is £2 8s. 9¾d. a head, and in the voluntary schools, to which those of Jamaica are akin, it is £1 18s. 1¾d.) These schools are subsidised by the State, and now receive grants in lieu of fees, which were abolished in 1893. During the last year, the average attendance has fallen from 66 to 60 per cent., but this fall is probably due in part to a reaction after the impetus given by the abolition of fees. The average salary of an elementary schoolmaster is £44 9s. per annum.

The teachers, both male and female, for these elementary schools are trained at five training colleges in the island; and the work done there is of much importance, for great power for good rests in the hands of these elementary schoolmasters in rural parts.

In addition to these, there are a number of higher grade schools; a secondary school will before long be opened at Montego Bay to supply the educational needs of the north side of the island; and technical education is appearing above the horizon. Both boys and girls can obtain in the island a good English education, and can crown it by taking in the island the degree of B.A. of London.

Once a year a scholarship for £200 per annum, tenable for three years at any one of the Universities of Great Britain and Ireland, is awarded. It is given to the boy (who must be Jamaica born, or a son of parents domiciled in the island) who passess best in the Cambridge Senior Local Examination, provided he comes up to a certain standard.

Forty-two other scholarships, varying from £60 to £5 are given every year.

At the last Cambridge Local Examination, of the seven seniors of the Jamaica High School who sat, all passsd, and of the 14 juniors, 12 passed, giving a per-centage of passes of seniors 100, as against 66·9 for England and the Colonies; juniors 87·5, as against 73·4; juniors over age 83·2, as against 61·2. The Honours percentage was for seniors 85·7 per cent., and juniors 50 per cent., as against 27·6 and 38·6 in the general list. And these results were obtained by sending up, not picked boys, but the whole of the upper forms—the only fair test.

There are three daily papers published in Kingston, one of which at all events would do credit to any town of like size in England; in addition to a number of periodicals issued at less frequent intervals.

There are troops in Jamaica to the number of about 1,700, consisting of a detachment of an infantry regiment and a company of Royal Artillery and Royal Engineers, and headquarters and four companies of either the first or second battalion of the West India Regiment, the rest of the battalions being in other West India islands or on the west coast of Africa. The rank and file of the West India Regiment, natives of the West India Islands, are in great measure recruited in Jamaica and Barbados. These men have frequently proved their efficiency and bravery in action. One wears the Victoria Cross; and, should fighting take place at Coomasie, the men of the West India Regiment will not be behind their European comrades in arms.

There is also a Jamaica militia, about 530 strong. At Port Royal there is a depôt ship and dockyard, and the North American and West Indian squadron visits the port once a year, and men-of-war of other nations, especially of the United States, are not unfrequently seen in Kingston's magnificent harbour.

As to sports and pastimes, there are cricket clubs in several towns, and, on the occasion of the visit of an English team to the West Indies last winter, several Jamaica-born cricketers gave a very good account of themselves. Lawn-tennis is much played, football is played in the cooler months in Kingston and Spanish Town, and the cyclists are growing in numbers. Yachting and rowing can be obtained in Kingston and other harbours, and there is shooting of pigeons of various sorts, and fishing in the rivers. To those interested in natural history, Jamaica offers numerous attractions—in geology, in insect and bird-life, in the world of plants, and in the waters round its coast, which has twice tempted students of the Johns Hopkins University to form a temporary biological laboratory in Kingston Harbour.

VII.—VISITORS.

There are a number of very good roads circling the island by the sea shore, and traversing it in all directions; the main roads are under the control of the Public Works Department, and the others are kept in order by the local authorities.

In a country like Jamaica nothing tends more towards the advancement of the people than the opening up of the country by means of roads, which carry the light of civilisation into the moral darkness of the bush; and the erection of substantial bridges over mountain torrents renders of use throughout the year, roads which were formerly only passable in fair weather. During the last few years, Jamaica has experienced a wonderful advance in this respect, the results of which will undoubtedly be seen in the near future.

Since 1889, the length of the main roads has been increased from 752½ miles to 1,839¾; and upwards of 100 new bridges have been constructed—many of considerable size; one over the Rio Minho, in Vere, is of a single span of 240 ft. During the financial year 1894-95, upwards of £100,000 was spent on roads and bridges. The heavy washings to which roads are subjected at the time of the season's rains naturally add materially to the cost of repairs.

These roads not only aid the peasantry to bring their produce to market: they also render the beautiful scenery of the inland part of the island more readily accessible to the tourist; and make travelling possible to many who would be deterred by the somewhat rough riding which it was necessary to undertake in order to see the island in the old days, and which is still obligatory on those who would explore the more hilly parts.

The best months in which to visit Jamaica are December, January, February and March, as they are the coolest, and also free from rain. The passage from Southampton to Kingston, by Royal Mail steamer, takes 16 days. There is a fortnightly mail: but postal communication with the mother country is also carried on by way of New York, which is reached in six days from Jamaica; and letters sent *viâ* New York not unfrequently reach their destination more quickly than those transmitted by the regular mail. Steamers bring tourists from time to time from the United States, and it is hoped that arrangements may be made for a regular series of such trips during the winter months.

The Royal Mail Company has, since 1892, arranged tours in the West Indies, occupying from five weeks to four months; and for those who can afford the time, it is a very pleasing change from the frost and cold of England, and especially the fogs of London, to the balmy air and beautiful scenery of the Islands of the Caribbean Sea, of which Jamaica is certainly not the least beautiful.

In connection with the holding of an international exhibition in 1891, and in anticipation of a large influx of visitors, four substantial hotels were erected under Government guarantee. Had the management of these hotels been but half as good as the structures, Jamaica might by this time have become a popular winter resort with Americans. In many of the country parts travellers have to be content with the old-time boarding-houses, where wholesome, if not elaborate, cooking may be obtained. A week or two may be pleasantly spent in one or other of the excellent lodging-houses in Mandeville.

The time at disposal will not allow me to tell you of the grazing pens of Westmoreland, Hanover, St. Anne's and St. Catherine, with their Herefords and shorthorns, and here and there zebus and Mysore cattle from India; the horse - breeding pens of St. Elizabeth; the pimento groves of St. Anne; the coffee estates of the Blue Mountains and of Manchester, where also grow the best oranges; the sugar estates scattered throughout the island, one of which near Kingston turns out in a week about fifty tons of sugar, enough to sweeten 2½ millions of cups of tea; the beauties of the Roaring River; the strange appearance of the Cockpit Country; the historic associations of Spanish Town and Port Royal; the pleasure of a trip round the coast in a coastal steamer, or a drive along the excellent road skirting the coast; and the grand scenery, which is to be found in almost every part of the island. But I will, with your permission, take you rapidly up to the Blue Mountain Peak, from whence magnificent views are obtainable.

For the convenience of visitors to the Peak, a hut was built some years ago, in which a meal, carried up on mule-back, can be prepared, and a night's rest obtained, for it is too great a distance from Kingston for the journey there and back to be made in one day. But by far the pleasanter way is to spend the night with some friend in the hills, or at a house where lodgings can be obtained, and visit the Peak next day at leisure.

An Eastern proverb says, "In the desert no man meets a friend." It might truly be said of Jamaica—In the mountains, no man lacks a friend; although everyone lives, as a rule, about two hours' ride from his nearest neighbour.

The wise traveller in Jamaica rises before the sun, for he thus not only gets two or three hours' cool riding, but is, as a rule, rewarded by seeing a magnificent sunrise. Soon after the sun is up, the freshness of the morning is gone, and one has to wait until an hour or so before it sets for it to be possible to ride in comfort in places exposed to its rays.

Leaving Kingston, the road rises gradually, until it reaches within about three miles of Gordon Town, at the entrance to the Port Royal Mountains, which take their name from that town of buccaneering fame, of the parish of which they at one time formed a part. On the road, one passes, on the right the Long Mountain, which is cut off from the higher ranges by the valley of the Hope river; on the left, the Jamaica High School, and the Hope Botanical Gardens, at an altitude of 600 feet, which, with Castleton in the centre of the island (580 feet), and Cinchona in the Blue Mountains (from 4,500 feet to 6,300 feet), enables plants requiring varying degrees of climate to be propagated.

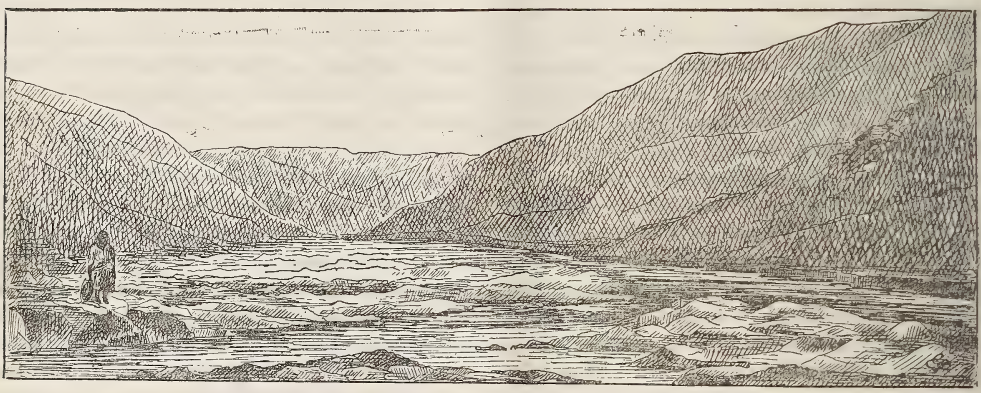
Just before reaching the sixth mile-stone from Kingston, the road makes a sharp bend inland, and one feels at once that the plains are left behind, and the hill district has been entered. The air is perceptibly cooler, vegetation is visibly richer, and the landscape becomes grander and more varied. The Hope river rushing along its rocky bed, which in time of drought seems ludicrously too large for it, but which when the season's rains, as they are called, are on, proves none too wide, offers many subjects for the artist's pencil. An undulating road of three more miles, and Gordon Town is reached; and if a buggy has been the means of locomotion hitherto, it must be relinquished for the saddle. A path to the left leads to Newcastle, where at an elevation of about 4,000 feet are stationed the regiment of English troops which, for the time being, are doing duty in the island. For the Peak, one takes the road to the right, past "The Gardens," now a private resiedence, in which Miss North made many of her drawings of Jamaica flowers, and which was for some years during the last century an Island Botanical Garden; in it are still to be seen many of the fine trees and plants, of which Bryan Edwards, the historian, gave a catalogue of upwards of five hundred varieties, gathered together by Hinton East, a planter and amateur botanist, of whose heir "The Gardens" was purchased by the Government.

Here was said to have been planted the first batch of mangoes, which brought from the East in a French ship, captured by Rodney's squadron, more than a century ago, took so kindly to Jamaica that, when in season during the summer months, the fruits may be seen strewing the country paths as thick as leaves in Vallombrosa, while their rich foliage makes a shade acceptable at any time.

Leaving "The Gardens," a steep ascent of four miles, the banks of which

> "Hang rich in flowers, and far below them roars
> The long brook falling thro' the clov'n ravine,
> In cataract after cataract to the sea."

brings us to Guava Ridge, through which a gap has been cut leading from one valley to the other, whence fine views may be obtained —to the west, over the plain of Liguanea to the Red Hills in St. Catherine, a view which looks best in the light of the setting sun; to the east, over the Yallahs Valley, whither the path to the Peak lies. For the next few miles it winds along the hill side, now up, now down, with a steep descent on one hand of many feet into the valley beneath; past many a negro hut, with its little plot of coffee, bananas, yams and other "bread kind," or if there be evidence of greater care and taste, it may safely be put down as a coolie dwelling; and every here and there it crosses some small rocky stream, which helps to swell the volume of the Yallahs ere it joins the sea. Past Mavis Bank, formerly a large coffee plantation, with its church and chapel prominently situated on the hill side, a steep descent leads to the river bed, just where the Green River joins the Yallahs, or Yellows, as some old maps have it, and yellow it can be in flood time, when it carries all before it—rocks, trees, and aught else that comes in its way, and like many other rivers in Jamaica, forms an obstacle impassable to man or beast. Now it is a harmless stream, easily crossed on stepping stones.



The Meeting of the Green and Yallahs Rivers.

Leaving the Port Royal Mountains behind us, and entering the range of the Blue Mountains, which often well deserve their name when seen from Kingston, we see forest trees in endless variety—mahogany, of which the Arawâk made his dug-out canoe centuries before it was used for the Thames skiff; cedar, with which the roofs of most Jamaica houses are shingled; and the cotton-tree which, king like, towers above its fellows. Another steep ascent of about three miles brings us to our destination for the night, where, situated as it is by one of the many gaps in the mountains, one gets fine views, embracing Cinchona, the Government Botanical Gardens and Plantations, the main ridge of the Blue Mountains, and the sea in the neighbourhood of Yallahs Bay, and including in its range all the principal estates where the celebrated Blue Mountain coffee is produced, and Albion on the sea-coast, where the well-known Albion (or vacuum-pan) sugar was first prepared.

At night here, at an altitude of about 4,000 feet, a blanket is needed, and in the colder months a fire is often acceptable. In the garden grow many a plant familiar to English eyes which cannot well stand the heat of the plains below — arums, verbenas, pinks and geraniums, and vegetables such as peas, potatoes, French beans, celery and Brussels sprouts.

Starting in the morning, the way lies through coffee plantations with their carefully cleaned fields of neatly topped coffee-trees with their bright-red berries, past works with their ranges of barbecues, each of solid concrete about the size of a tennis-court (to which use they have in some places been not unfrequently devoted), on which the coffee is dried, before being prepared, with an amount of anxiety and care undreamt of by many a Londoner who sips his morning cup over his *Times*. Here all is order and neatness, and the forest trees have been cut down, for at this elevation coffee suffers when too much shaded.

In a short time, leaving the last of the coffee estates, for, though coffee likes high lands, it will not stand too bleak a situation, the ascent to the Peak begins in earnest and can only be accomplished in comfort on a mule or some pony used to hill-climbing. Entering a tract of forest, one sees timber trees in endless variety—trees which cabinet-makers would gladly possess, but which cannot be turned to much practical use owing to the difficulty and cost of transport. Yacca, most beautiful and most workable of woods; juniper cedar, with its beautiful grain; satin-wood—well-named; grey mountain sanders, which takes a fine polish, and many others. The tree-ferns, growing in the shady gulleys, lift high their umbrella-like heads towards the light, in some cases to a height of twenty feet or more, but the stems lack the massiveness of the Australasian species; and they lend a truly tropical aspect to the scene, which—but for them and the beautifully delicate climbing bamboo—would not be unlike the wooded heights of North Devon. Here and there may be seen a coratoe (or maypole, as it is commonly called), which when in flower seems like an obelisk of gold, well set off by the surrounding green.

The stillness is only broken by the melancholy note of the solitaire, which Gosse likened to the tone of a flute, and a John Crow, or turkey buzzard, soars aloft, keen alike of sight and smell, ungainly as a goose on the ground but almost majestic in the air; and, anon, a mongoose runs swiftly across the path.

Soon we reach a clearing of many acres covered with cinchona trees, which about fifteen years ago were thought to be about to prove a veritable gold mine to the island. Unfortunately a change in the state of the quinine market upset all calculations, and the industry has proved fruitless. On attaining an altitude of nearly six thousand feet, we enter the region of that cloud-cap which is usually seen from Kingston to be reposing on the Peak, and we begin to fear that we shall share the fate of many another visitor before us, and have no view to-day. We now reach Portland Gap where at a height of 5,550 feet stands the highest house in the island. A few hundred yards further on is obtained, in clear weather, a view over the north side of the island extending to Cuba 100 miles away. For us there is no such extensive view, but one more curious: a break in the gloom discloses Port Antonio with its double harbour, illumined by the sun's rays and set in a frame of mist—Port Antonio which may almost be said to live by the banana trade, and whence in the season many shiploads go to the United States. Still upwards, in a natural basin, where the wild pigs were wont to wallow till it was filled up, our ponies get over their fetlocks in the mud. On reaching the Peak itself, the view, is, as we feared, mist. The popular idea is that in order to make sure of getting a view it is necessary to sleep the night in the hut, as it is clear at sunrise; but those who live in the neighbourhood say that though, except in the rainy season, it is probably clear during some part of the day, there is no reliance to be placed on any particular hour. While we are there, the mist lifts and discloses the Yallahs Valley in bright sunshine six thousand feet below; but in a moment it is gone, and all is mist again. On a clear day, the pens and sugar estates on the coast to north and south may be seen with microscopic clearness, and Cuba and Haiti (or San Domingo) are also visible to the north and east. The thermometer kept on the Peak for meteorological purposes registers 53 degrees, and after the normal state of the temperature in Kingston, it is quite pleasant to feel cold. On our way down, we heard the tinkle of the "budge" bell, summoning the hands to work after their morning meal on some coffee estate a thousand feet below. Leaving our hosts, we decided to return by another route, which, though longer, would enable us to see another part of the country, not that there is any great variety in the scenery of parts of the Blue Mountains at a similar level. The road took us down to Hagley Gap, with its post-office, constabulary station, and the few accompanying shops which naturally gather round those institutions in the country: hence fine views are gained to east and west. A ride of about two miles, somewhat trying by reason of the heat reflected by the sun-baked cliff, brings us again to the Yallahs Valley, here crossed by a substantial bridge, and, passing the graves of the former owners of an estate, who were—as was then the custom—interred upon their own properties, our road gradually ascends crossing numerous picturesque stream-lets, till Guava Ridge is reached once more; and so home.

In conclusion, I trust that I have shown you that Jamaica — at once the largest of the British West India Islands, and an island possessing a greater variety of climate and products than any other, and affording as healthy a residence as the best of them—has interest to the lover of history, especially of the British Empire, and that should be to every Briton; to the naturalist; to those in search of health and of relief from the trying climate of an English winter; and to the agricultural settler with a certain amount of capital, who is prepared to take the country as he finds it, and does not expect to change his home without changing his mode of life. And I feel sure that the paintings and photographs on the walls, kindly lent by Mr. Washington Eves, and the drawings of fruits borrowed from the Jamaica Court of the Imperial Institute, by the courtesy of the authorities of that institute, as well as the views which have been exhibited to you by means of the lantern, will have convinced you that Jamaica possesses scenery of great variety and beauty.

THE YALLAHS VALLEY.

DISCUSSION.

Sir FREDERICK YOUNG, K.C.M.G., thought they must all be extremely indebted to Mr. Cundall for this interesting paper, and for the valuable description which he had given of Jamaica. He had been delighted with the comprehensive character of the paper itself, which, in his opinion, was worthy of very extensive circulation, as it gave a wide and excellent description of the history of Jamaica, both in ancient and in modern times. Mr. Cundall's account of the progress of the various industries and trade of the island, would also give some encouragement to those who had held rather pessimistic views in regard to the future of Jamaica. He was old enough to remember Jamaica in its supposed palmy days, as a good many of his family had to do with Jamaica and its trade, the important article which was the sustenation of the island in those days being sugar. Every one knew how in the course of time the prosperity of that article had departed, but other industries were now taking their place, and afforded great promise for the future prosperity of the island. It was impossible to go through the various points of the paper, but he had been struck with one or two facts to which he might refer, for instance, the negro population, and the encouraging hopes which might be entertained of them in future. Considering the long period of slavery which the negroes had undergone, it was surprising that they showed so much aptitude for civilisation. He believed that there was a great future before that race, as well as for Jamaica in a commercial point of view.

Mr. STEPHEN BOURNE said, having been connected with the island of Jamaica 60 years ago, he was very pleased to find on the walls of that room a graphic picture of the roof under which he first slept in Jamaica, and to see the beautiful photographs conveying so splendid an idea of the tropical growth of the country. He was very glad to hear the changes which had taken place since he had left the island. It had been said that Jamaica had been ruined; this was the idea of those who attached importance to a colony for the wealth which it brought to the mother country; but when he first knew the island, and, in fact, in days long anterior to that, the whole of the profit derived from the employment of labour in the cultivation of the soil came home to swell the grandeur and the idleness of those who were living in this country on the sweat and blood of the poor negro. Now the case was very different. One very striking evidence to be gained from the photographs was the prosperity of the inhabitants, as shown by their clothing. No doubt they had been struck with the peculiar mode in which the washing operations were carried on as depicted by the photograph, viz., the clothes were taken down to the river and beaten with a stone or wooden beater in order to force out of the texture of the linen that which it was desirable to get rid of; but when he was in Jamaica the clothing of the women was certainly much more fitted for an exhibition in an artist's studio than it was to present to the eyes of a modest man like himself. The extension of the garments was a striking improvement in the advance of civilisation. The same was to be seen in the case of the men, showing that both men and women must have employed the labour of their hands to considerable advantage in procuring clothes. The prosperity of the country had been retarded owing to the false principle of some political economists. The old employer of negro labour could not conceive the possibility of extracting valuable work from the negroes, except by means of the lash or some other mode of compulsion; it was quite foreign to their idea that a negro could enter into an agreement as a free subject, and so a system was devised of crushing down by a low rate of wages. The old system was for the negro to work so many days for his master, and to have so much of his time allotted to himself—generally speaking, half of Saturday and the whole of Sunday—which time he devoted to the raising of crops on which he had to support himself. A large number of the negroes who were not so thrifty as others were disposed to sell their time to the services of masters, the established rate of wages for a negro being 1s. 6d. a day, and 2s. for the owner of the slave when he hired him out to somebody else. After slavery was abolished, the masters said they would give the negroes the free use of their house and ground, so as to make them dependent upon their own labour for their living and clothing, and also give them the sum of 4½d. a day for work. The negroes declined to accept this, and there was an exodus from many of the estates. This led a number of English philanthropists, who were not very good political economists, to purchase for the negroes holdings in the interior of the island, where they were far removed from sources of employment for wages. Thus, although well provided with food, they found it difficult to procure clothing and most luxuries which required money to purchase. The staple products of the island for export were much diminished, but this was now probably being overruled for good. The new system had tended very much to develop the productions of the island in the way of cultivation of fruit, and they were now not so dependent as formerly upon sugar. With improved teaching and morals, they would find the resources of the island greatly improved, and England, as well as the United States, would be supplied with tropical fruits. He was very much attached to Jamaica, and looked forward to the time when it would again become one of the first treasures of the British Empire.

Dr. JOHN PRINGLE thought the paper formed a red-letter on the literary side of Jamaica. Although it was not usual on such an occasion as the present to introduce controversial matters, he might say that he had carefully studied both sides of the question, and had come to the conclusion that it was a mistake to imagine that every owner of slaves drove them. In the majority of instances the slaves were as fond of their masters in the olden days, as many children were of their parents at the present time in Jamaica. It was, unfortunately, true that some slave owners were not quite what they should be, and "did evil in order that good might come" of it. The past history of Jamaica, in the Spanish time, was peculiar; it was evident that the Spaniards did not visit Jamaica for literary purposes, consequently there was nothing left in that direction, and we had to resort to the caves of the earth for information of Jamaica during that period. Later on they found that more attention had been paid to the literary side of Jamaica, and a fair description of the colony was preserved. Jamaica was now very fairly prosperous, and this had been mainly contributed by the foresight of its governors. The island was, for instance, indirectly indebted to Sir Anthony Musgrave for the present paper, as he founded the Institute in Jamaica which had been liberally treated by the present Governor, Sir H. A. Blake. He thought, also, they had been very fortunate in getting a gentleman like Mr. Cundall to fill the position which he now occupied in Jamaica, namely, Secretary and Librarian of the Institute of Jamaica. The first industry of Jamaica, viz., the fruit industry, which was carried on very successfully, had now reached a crucial stage, and it behoved those interested in the colony to try and induce the Government and the various fruit cultivators to introduce into England the varied and excellent fruits of the colony. An attempt had been made through private enterprise to introduce bananas, but he thought that this industry, to be successfully carried out, would require a subsidy from the Government. As a general rule he did not approve of subsidies, but he thought in this instance a subsidy, if judicially spent, would produce good results. If the industry was sought to be conducted by private enterprise it would probably fail, but with a little help from the Government bananas might be shipped to Great Britain just as easily as they were shipped to the United States.

Mr. GEORGE HUGHES said that he had had the pleasure of visiting Jamaica, and had been very much struck with its scenery. Having visited all the West India Islands he thought the palm in this respect must be given to Jamaica. One important industry which he hoped would continue was the manufacture of rum, and he thought it was a great point for the colony that, having established a reputation and demand for that commodity, they should continue to produce it up to the present standard of excellence. Upon the reading of a paper recently at the Royal Colonial Institute a good deal was said about the necessity of establishing central factories for planters, but he thought that nothing should be done in this direction that might deteriorate this speciality of Jamaica. Demerara was practically a system of central factories, and had established a reputation for Demerara sugar, so much so that it had been found profitable to fraudulently imitate it here by colouring beet sugar yellow with chemicals. Again, Barbadoes had obtained a reputation for its molasses and the sweetness of its Muscovado sugars. It was exceedingly desirable that a colony having established a reputation for any particular article should not be carried away by any new schemes, but should continue to manufacture their staple article in the best way they could, and that would probably be found by continuing, he thought, on the present system of production adopted by the planters of the different West Indian colonies.

The CHAIRMAN felt sure that everyone would agree that they had had a most interesting and comprehensive account of the Island of Jamaica, and the information given by Mr. Cundall would be of great service in making the island better known as a field for settlement, and as a winter resort for the invalid and the tourist. The facts and statistics which had been put before them showed that the island was steadily progressing, and that its natural resources were being rapidly developed. Dr. Pringle had alluded to what former governors had done, but he (the Chairman) thought that His Excellency the Governor of Jamaica, Sir Henry Blake, had reason to be proud of the island's record during the past six years. Taxes had been reduced by £45,000 a year. Foreign postage had been reduced from 4d. to 2½d., and inland postage from varying amounts to 1d. Kingston had been drained; 400 miles of telegraph had been added; 1,000 miles had been added to main roads; waterworks had been constructed in every town; markets had been built everywhere, and 150 bridges had been built. Schools had increased from 800 to 1,000; scholars from 74,000 to 104,000; the Exhibition of 1891 had been successfully carried out; new industries had been started, and an Agricultural Board had been created. Besides this, 120 miles of railway had been built; plans and estimates had been made, and a loan authorised for the construction of a new lunatic asylum and public hospital, and for a new sea-wall for Kingston, were before the Colonial Office for approval, and finally there was a surplus of £50,000 to go on with at the end of the financial year. This he thought was a wonderful six years' record of administration. In conclusion, he begged to propose a hearty vote of thanks to Mr. Cundall for his interesting and instructive paper.

The vote of thanks was carried unanimously.

CANTOR LECTURES.

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M.Inst.C.E.

Lecture II.—Delivered December 9, 1895.

At the conclusion of my first lecture I briefly referred to the steam coaches of Summers and Ogle, of Macerone and Squire, of Dr. Church, and of Hill. In view of the unquestionable priority in the design and working of steam coaches, of Gurney, Dance, Hancock, and his man Bish, and of the men above-mentioned—priority of at least a generation ahead of any that followed, and of more than half a century as compared with continental mechanical road carriage-makers—a few more notes on some of their carriages may be of interest.

Hancock built nine steam vehicles*, six of which were fitted with the boilers which I have described. To this boiler, Figs. 14, page 99, I would again draw attention as an example of an excellent form of portable boiler for high pressure and high duty, and one which might be very cheaply made. Hancock's success was remarkable, and it may be said that the steam coaches he made, and those of Gurney, and Macerone and Squire, were, as road carriages, at least as fully developed as were the locomotives and carriages on railways at the same date.

The boiler used by Colonel Macerone and Squire was illustrated on page 100. It was a vertical watertube boiler with a central steam receiver, and worked at 150 lbs. Several of these pioneers of the mechanical road carriage successfully used pressures which are only now becoming common, although if their example had been followed millions of tons of coal would have been saved.

The engines used by Macerone and Squire had pistons 7·5 in. in diameter and 15·75 in. stroke, the cylinders being fixed on the perch-pole under frame as shown at Fig. 20, page 102, *ante*. They were coupled direct to a crank-shaft forming the driving axle. With Gurney, the use of a crank-axle was the source of much trouble Hancock avoided by his arrangement. The furnace was fed from a hopper and was almost self-feeding, forced draught being obtained by the use of a fan driven from a pulley on one of the road wheels.

It is recorded that this coach ran 1,700 miles without noteworthy repair. They used coke, which, at the then taxed price, cost from 3d. to 4d. per mile. The average speed is said to have been fourteen miles per hour, a speed which apparently was aimed at to compete with the mail coaches. The horse coaches paid then about 3s. per mile for four horses, according to speed, which was seldom more than about ten miles per hour.

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* "Steam on Common Roads." Young, Holley, and Fisher. London, 1860.

It may be here noted that Mr. G. F. A. Des Vignes, of the Orleans Boat Yard, Teddington, possessed Hancock's drawings of engines and boilers until nine years ago, and he had also the mould into which the plates were stamped to form the boiler. He received them from the late Mr. Peter Hubert Des Vignes.

Church made his coaches between 1832 and 1835. His designs were unique and show that he realised that the comfort of the passengers and the attractiveness of the vehicle were as important as the boiler and engines. His boiler as shown in the alternative forms of combined water-tube and water-space boiler, and combined water-space and tubular boiler are deserving of high praise even now. It is susceptible of improvement in boiler makers' details, but the general design would do credit to many makers now, and some of the points of his design have been used as novelties very long since Church's coach was stopped by the opposition and restrictions of the time.

For an adequate description of the opposition, against which the users of the steam-coaches were powerless, I must refer to the evidence given before the Select Committee of 1831.* Attempts were made to reform the Turnpike Acts, but without avail. It was proposed to make the tolls the same as that charged for horse-hauled vehicles of similar carrying capacity, but with little success. The following shows what the tolls were :—

Tolls in 1831.

	Coach.	Steam.
Liverpool-Prescot	4s.	£2 8s. 0d.
Bathgate-road	5s.	£1 7s. 1d.
Ashburnham—Totnes	3s.	£2 0s. 0d.
Teignmouth—Dawlish	2s.	12s. 0d.

In these days, the four-horse coaches weighed from 15¾ to 18 cwt., and the mail-coaches nearly 20 cwt.

As the result of three months' inquiry, the Select Committee of 1831 reported completely in favour of steam-coaches. The following is a summary of their conclusions :—

"1. That carriages can be propelled by steam on common roads at an average rate of 10 miles per hour.

"2. That at this rate they have conveyed upwards of 14 passengers.

"3. That their weight, including engine, fuel, water, and attendants may be under three tons.

"4. That they can ascend and descend hills of considerable inclination with facility and safety.

"5. That they are perfectly safe for passengers.

"6. That they are not (or need not be if properly constructed) nuisances to the public.

"7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

"8. That, as they admit of greater breadth of tyre than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.

"9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered."

It must be remembered that the opposing interests of the day looked upon the steam road-carriage as an addition to the great modifying power of steam on the railways, which was making itself felt. The locomotive, however, was on its own ground, while the road-carriage was on everybody's ground, and could be fought and molested in very many ways. The history of the time shows that the pioneers in steam road-carriages failed in spite of their splendid achievements—1, because capitalists were absorbed in railway enterprise; 2, prejudice; 3, tolls; and 4, because the Tolls Bill fell through, as it did again in 1859.*

It is curious to note that in 1830 Galloway wrote, "Locomotion as applied to our common earth or paved roads is an art which may be regarded as still in its infancy. This is not the case, however, with locomotion on railways, which appears to have nearly attained maturity, and to be rapidly advancing towards perfection."

On the other hand, Gordon wrote in 1832 (p. 52), "It is not yet publicly known that these locomotive engines, powerful and swift as they are, must either be worked at a cheaper rate or abandoned; so at least, I am well informed."

We now reach the period of the development of what we may call the steam cart-horse, as compared with the steam carriage-horse. The latter being refused all opportunity or hope of obtaining tolerance, or even recognition, as a beneficial institution, almost all invention or enterprise ceased, but the construction of the heavy hauling engine for agricultural and other requirements commenced. My grandfather, William Worby, seems to have initiated it, for he made the first agricultural self-moving engine.* He had made the first portable farm engine as exhibited by Messrs. Ransomes of Ipswich at the Liverpool Show of the Royal Agricultural Society in 1841, and then made the self-moving engine exhibited at the Bristol Show in 1842. This engine was tried, and travelled at from four to six miles an hour, and was hailed as a great novelty and awarded a prize. It was a simple carriage, carrying a vertical boiler and a Davies rotary-disc engine. The latter was connected to the driving wheel by means of a pitch chain.

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* Gordon, A.—"Elemental Locomotion," 1832.

* "Steam on Common Roads," Young; 1860; p. 407.

During the period of development of the steam cart-horse, to which I must refer as some of the points are of interest in connection with lighter steam road vehicles, some efforts to run the latter were made. In 1848, Mr. J. W. Boulton made a steam-moved vehicle with a frame of 9 feet in length, and with a vertical boiler supplying 60 lbs. steam to an engine with two cylinders, 3 in. by 6 in. the crankshafts of which were connected by a pitch chain—with a ratio of 5 to 1, to one of the road wheels, the other being loose. No reversing gear was used.

The difficulties connected with the working of agricultural self-moving engines over most of the country roads made it desirable to find some means of forming an artificial roadway, and this, after attempts by numerous inventors, was effected by Boydell's endless railway as it was called. It was a wheel provided with a number of flat shoes attached loosely by means of links, but so that they constantly provided the wheel in its rotation with a segmental rail to roll upon.† It was patented in 1846, and some years afterwards was made by Mr. Charles Burrell of Thetford in considerable numbers for traction engines used for various purposes, and was also tried for hauling ploughs and other implements by direct traction across the fields. Although Boydell's wheels were very successfully used for agricultural engines by Mr. Chas. Burrell, and by Messrs. Garrett, of Leiston, by whom also they were fitted to farm carts for getting easily over soft lands, they were attended with a good deal of wear, and, for road purposes, ceased to be used when the improved form of self-moving engines with chain gear were introduced by Garrett and Son, in 1858, and by Thomas Aveling, who, in 1860, exhibited one at the Canterbury Show of the Royal Agricultural Society, and an improved one in the 1862 Exhibition. Messrs. Garrett and Sons' engine of 1858 had a pitch chain running on a pinion on the crank-shaft, and on a toothed ring on one of the road wheels. From this date development rapidly took place along the lines of what may be called the portable engine-boiler made self-moving. Mr. Aveling and Mr. Burrell took a leading part in this, and Messrs. Aveling and Porter, and Messrs. Garrett and Messrs. Chas. Burrell and Sons, carried on the improvements, which, in their hands, and those of Messrs. John Fowler and Sons, Messrs. Ransomes, Sims and Head (now Ransomes, Sims and Jefferies), Messrs. J. and H. McLaren, Hornsby, Foden, Robey, Ruston, Proctor and Co., and Messrs. Marshall, Sons and Co., have resulted in the powerful road-locomotive and traction-engine, or steam cart-horse of to-day. These engines are all worked on the lines of the portable engine on top of the boiler. The reason for the development on these lines, is, probably, due to some extent, to the fact that these engines had to perform the double duty of road locomotive or traction-engine, and portable engine for driving threshing and other machinery from its fly-wheel. It is, however, perhaps as much due to the fact that the lead was taken by making a portable engine self-moving, and that, bit by bit, following the lead thus set, the different makers mentioned, concentrated design in that direction without reference to the possibility of a better line of development. The fashion, in fact, was set, and although Messrs. Robey and Co., and Messrs. Ruston, Proctor and Co., and, I think, Messrs. Marshall, Sons and Co., have made at least one effort to introduce road-locomotives with much smaller amount of gearing, and with the engines placed under the boiler, no continued effort has been made to follow up this line of development, in spite of its advantages.

A very good model for road locomotive work was that of the engines made in 1858 and 1860, by Thomas Rickett, of the Castle Foundry, Stafford. These engines are shown by Figs. 22 and 23. Fig. 23 was made for the Marquis of Stafford. The boiler was of the return-tube kind, fired by an attendant on a platform at the rear. The engine had two cylinders, one on either side of the engine, the connecting rods passing to a crank shaft in front of the boiler under a seat carrying the

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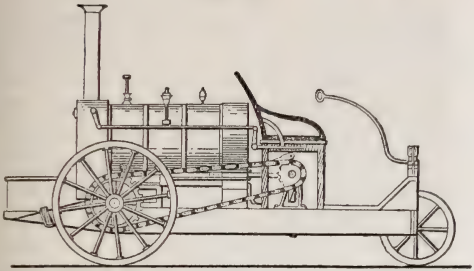
* *The Engineer*, 27th June, 1879; and "The Journal of the Royal Agricultural Society," vol. 11, p. 338.

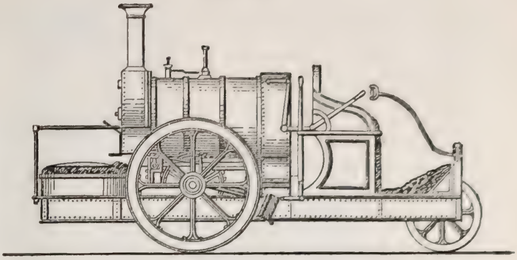
† "Steam Locomotion on Common Roads" by John Head. "Proc. Inst. Civ. Eng.," vol. xxxvi. 1873.

FIG. 22.



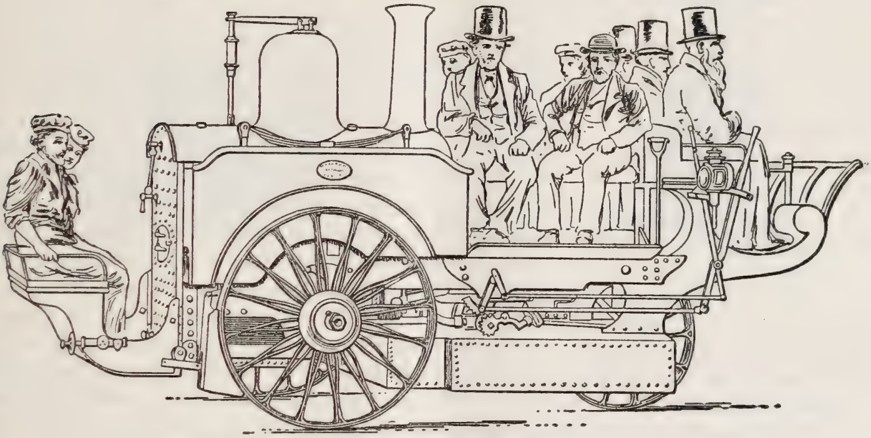
THE MARQUIS OF STAFFORD'S STEAM CARRIAGE.
1858 (Rickett).

FIG. 23.



EARL OF CAITHNESS CARRIAGE.
1860 (Rickett).

FIG. 24.



CARRETT'S STEAM CARRIAGE, THE "FLY-BY-NIGHT."

riders. On one end of the crank shaft was a pinion for a pitch chain which drove the rear and driving axle, upon which was a pitch chain wheel, two and a half times the size of the pinion. The cylinders were 3 inches in diameter and 9-inch stroke, worked with a steam pressure of 100 lbs. per square inch. The driving wheels were 3 feet in diameter, and the vehicle loaded weighed 30 cwt.* The second engine* was made for the Earl of Caithness, and was very similar, but the crank shaft instead of being under the seat was just in front of the fire-box, as shown in Fig. 24, and a pinion upon it geared into a spur wheel on the driving axle. These were simple engines, and it seems possible that they might have formed a useful model as a starting point for the development of road locomotives for heavier work, the necessary arrangement for driving machinery by belt being provided either by jacking up and using a road wheel, or by detachable pulley on the the projecting end of the crank-shaft between the framing and the road wheel, the latter being moveable for the purpose. Rickett's second engines were similar to the first, but weighed, loaded, 50 cwt.†

In 1865, Rickett made another road locomotive, the cylinders of which were 8 inches in diameter and 28 inch stroke, and were coupled direct by coupling-rods to outside crank-pins on the driving wheels. The engine weighed 6 tons, and was used for hauling coaches. A steam carriage of somewhat similar type, but differing in most of the essential details, as shown by Fig. 24, was made in 1861 by Mr. W. O. Carrett, of Carrett and Marshall, Leeds,† and exhibited that year at the Royal Show, and in 1862 in the great Exhibition. It weighed 6 tons 15 cwt., and had two cylinders 6 in. by 8 in., geared, I believe, 4 to 1, not 5 to 1 as has been before recorded. It had separate expansive valves, and was fitted with differential gear for turning corners. The boiler was of the locomotive type, fire from the rear, 5 ft. 3 in. long without smoke-box. It was 2 ft. 6 in. in diameter, and had 78 copper tubes of $1\frac{5}{8}$ in. diameter, all of which were brazed into the fire-box. The fire grate was 23 in. by 21 long copper box. After it had been used some time, 22 field tubes 2 in. diameter were put into the fire-box. It carried a pressure of 150 lbs., afterwards raised to 175 lbs. The water-tank carried 103 gallons. It had a feed-water heater, consisting of two sets of tubes 2 in. diameter, with internal tubes $1\frac{1}{4}$ in. The water passed between inner and outer tubes, all of which were screwed into flat chambers at either end. This engine was carried on three wheels, and when Mr. Carrett gave it to Mr. Frederick Hodges, of the London Distillery, it became known as the "Fly-by-night." Mr. G. F. G. Des Vignes and others with Hodges, ran the "Fly-by-night," about 800 miles, chiefly through Kent, and after being several time summoned for running at high speeds, they mounted it with fire hose and paraphernalia of a fire engine, and wore helmets of brass, and thus escaped legal interruptions for some months. It was however in the end converted into a slower self-moving engine.

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* Fletcher, "Steam on Common Roads," p. 151. *The Engineer*, 7th March, 1859, and 20th September, 1890.

† "Yarrow on Steam Carriages." "Transactions Society of Engineers," 1862, p. 128.

* Young, "Steam Power on Common Roads," p. 92.

† "Yarrow on Steam Carriages," and "Fletcher," p. 158.

Mr. A. F. Yarrow*, now so well known in connection with torpedo and other fast boats, made a self-moving carriage in 1863. It had a vertical boiler 3 ft. 9 in. high, 2 ft. diameter, and cylinders 5 × 9 in., coupled direct by outside connecting rods to driving wheels 3 ft. in diameter. Its weight was $2\frac{1}{2}$ tons, and provided seats for about a dozen people.

In 1862 Mr. Richard Tangye† made a steam carriage, the frame of which was 16 ft. long and 5 ft. 9 in. wide. It had cylinders $5\frac{1}{2} \times 11$ in., with connecting rods coupled direct to road wheels 3 ft. in diameter. The boiler was vertical with copper fire-box carrying 100 brass tubes. All these are illustrations rather of vehicles for engine and boiler, but with attached seats, rather than passenger carriages worked by mechanical out-of-sight power, but they were good machines, and would, if the law had not been against them, made excellent models for development of vehicles of the steam carriage type.

Reference must now be made to the self-moving engines introduced by the late Mr. Thomas Aveling, who, in 1860, exhibited one at the Royal Agricultural Show, Canterbury, where it appeared classed as a miscellaneous exhibit. A similar engine was exhibited by Messrs. Aveling and Porter, in the great Exhibition of 1862. This is shown by Fig. 25, which shows the method of driving by pitch chain from a pinion on the boss of a spur-wheel worked by a pinion on the crank-shaft, the spur-wheel and chain pinion running on a stud-spindle as shown in detail. This stud spindle arrangement gave a good deal of trouble even after the method of fixing it was improved compared with that shown, and in fact these stud-spindles appear to be things to be avoided for any hard work. It is difficult to keep them lubricated, and difficult to prevent their working loose or from bending. The steering gear of these engines was of the same type as that used by Guruey and others, but Aveling used one of the disc pilot wheels first used by Worby in the self-moving anchor for steam ploughing in 1857-8. The engine and details shown are those of the 1862 Exhibition engine*, and in this the stud-spindle was made movable in a slot curved to the radii of circles struck from the crank shaft, so that the chain could be tightened without affecting the pitch line distance of the spur-wheel and crank-shaft pinion. After some improvement and increase in strength a good many of these chain engines were made, but the chains were ultimately given up in favour of gearing because the stretch and wear of the chains gave great trouble on heavy work. The pull upon these chains was very heavy, as will be seen when we remember that an engine capable of giving off from 30 to 40 horse-power at about 180 revolutions per minute transmitted this through a chain running on a pinion the speed of which was only about one-fifth that of the crank-shaft. These conditions, notwithstanding the success Mr. Aveling achieved, were of course very adverse to the success of a chain which must run at a high speed to bring the pull upon it to a sufficiently low one to realise its advantages.

This was recognised many years later in a self-moving engine, made by Messrs. Garrett and Son, to which reference will be made hereafter. The heavy pull on the chain was also reduced by Mr. Chas. Burrell in 1868-9, by using two chains, as shown in Fig. 26. By this means the pull on each chain was reduced

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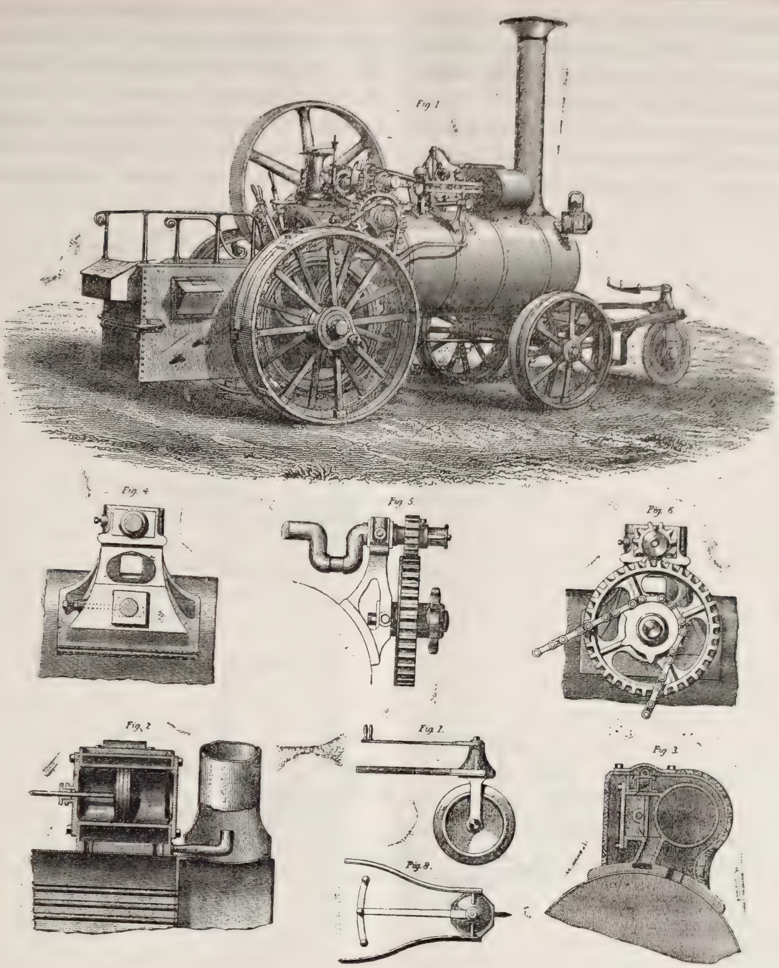
* Yarrow, "Soc. Eng. Trans.," 1863.

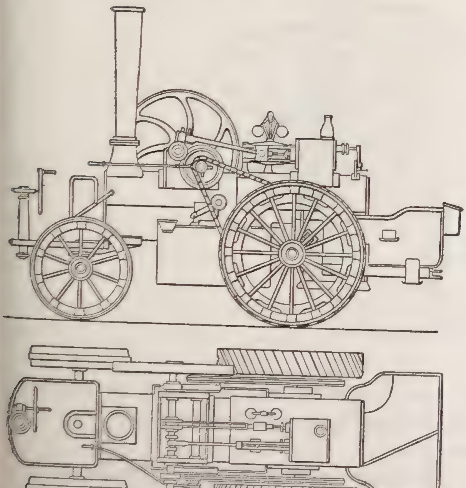
† "Steam on Common Roads," Fletcher, p. 164.

* "Record of the International Exhibition, 1862." London: W. Mackenzie, p. 134.



AVELING'S SELF-MOVING ENGINE (GROUP FIG. 25).

FIG. 26.



BURRELL'S DOUBLE-CHAIN ENGINE.

by about one-half. The arrangement also avoided the difficulty connected with the use of a stud-spindle, the latter being replaced by a strong counter-shaft across the engine, carrying spur-wheels of two sizes, for two speeds. The objection to this was the transmission of the heavy pull on one of the chains by the torsional strength of the secondary shaft driven from one end. On the other hand the driving axle was relieved of similar torsional stress. In Burrell's engine the weight on the driving-axle was carried by volute springs, the axle-boxes sliding in guides placed angularly, so as not to interfere with the action of the chains.

In a form of self-moving and traction engine made in 1871, by Messrs. Garrett and Son, the high speed of the chain was secured by running it on a pinion on the crank-shaft and driving by it a second motion shaft, on one end of which was a pinion which geared into an internal gear wheel of large diameter on one of the driving or road wheels, the driving axle in this case transmitting the power to the other driving wheel by torsional strength.

Chains continued to be used for some years in gradually reducing numbers, gear being used in its stead. The gear for a long time gave great trouble by breaking, and the teeth were made wider and wider to avoid this without very satisfactory results. At last Mr Aveling slightly increased the pitch of the teeth and reduced their width by about one-half, and by this one change overcame all the breakages except under abnormally heavy work or accidental occurrences and wear. The use of cast steel for the gearing has entirely obviated all breakage of this kind, but even now it is the practice to obtain the necessary strength of teeth by thickness rather than width. The gearing however in these engines is now large in quantity and the frictional losses are much greater than with the chain engine.

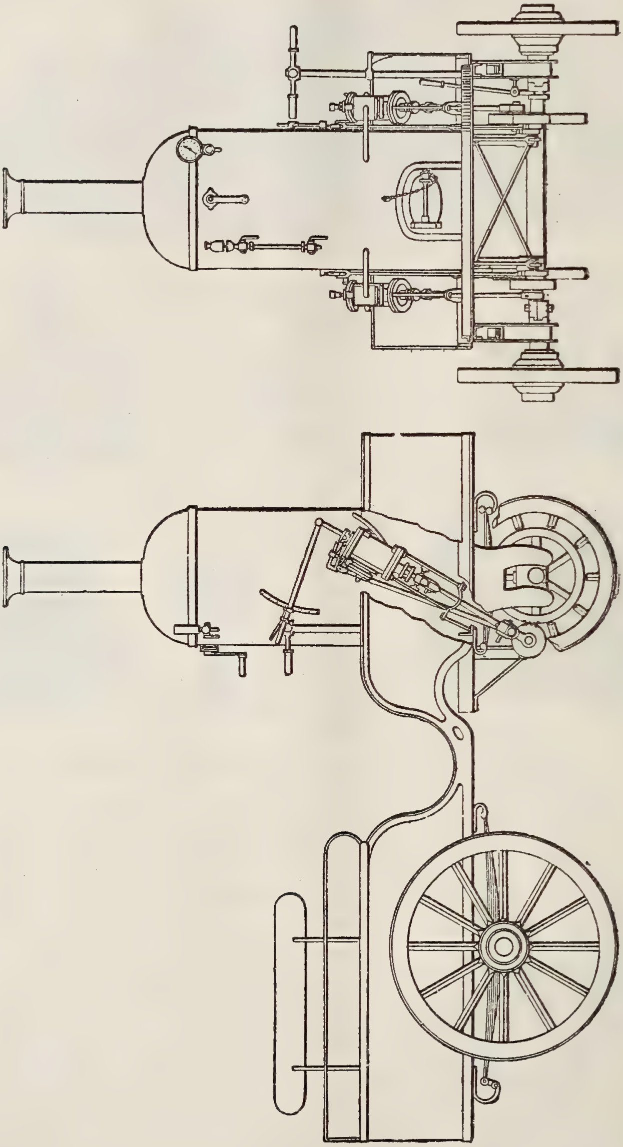


FIG. 27.

PATTISON'S STEAM CARRIAGE,

The next great step in the development of the steam locomotive on roads was made by W. R. Thomson who was the inventor of pneumatic tyres for which he took out a patent in 1845[*] In 1867 he used large rubber tires on traction engines, and in 1870 he ran in Edinburgh an omnibus drawn by one of what he called his road steamers fitted with rubber tyres. The omnibus was also fitted with india-rubber tyres and with springs 5 feet in length, and was made to carry 60 passengers, but when fully loaded it was found that the deformation of the rubber tyres added to the resistance. After a few months the experiment was discontinued, but Thomson's road steamers were destined to be made in numbers.

A steam carriage made in 1862 by Mr. A. Patterson must here be noticed. It is illustrated by Fig. 27,[†] and is still in existence though incomplete, the engines having been taken out when the red flag Act of 1878 came into force. The boiler and engines were carried on a circular frame with a flange at the bottom. A corresponding circular ring in the frame of the fore part of the carriage, served to connect engines and carriage and allowed the engine and boiler to turn on the front pair of wheels, which carried the whole of their weight. A circular rack on the first mentioned ring and a pinion provided the steering gear. One driving wheel could be thrown out of gear by a clutch; the other had a friction clamp lined with wood with sufficient grip of the driving shaft to assist in driving and yet allow for turning corners. The cylinders were 3 in. diameter, 6 in. stroke, and drove by spur gearing. Water was carried under the back seat and fuel underneath side seats. The working pressure was 100 lbs., and the weight in working order was about one ton.

In 1871 a self-contained steam omnibus was brought out by Nairn, and run four months between Edinburgh and Portobello.[‡] It was named the "Pioneer," and its history, however, was one of failure, from causes common to the failure of many. At the rear of the omnibus were three cylinders, 7·5 diameter and 10·75 stroke, coupled direct to 3 ft. 4 in. driving wheels. The boiler was a combination of water and smoke tubes, with only 2 ft. grate surface and 120 square ft. of heating surface. The chimney passed to the rear under the seats of the outside passengers, and discharged the smoke and exhaust over the conductor's head, the exhaust being regulated by a cone and screw. In front the omnibus was carried on a single 3 ft. 4 in. wheel in a fork. The omnibus was carried over the main axle by leaf springs, 4 ft. 6 in. long, supplemented by pendant volutes and india-rubber washers 4 in. thick. Over the leading wheel were four volutes and rubber washers. The weight, with coke and water, was 7 tons 8 cwt. and with 50 passengers 10·5 tons. During the four summer months of 1871 this is said to have run the three mile journey from 11 to 12 times per day, carrying an average of 21 passengers, and making in all 952 runs. At the end of this, however, the whole of the working parts had practically to be renewed, the wear being so great in consequence of the admission of dust and mud to all bearings and rubbing surfaces. The wheels being only 40 in. in diameter, the cylinders and all connections were necessarily very near the ground, and the experience was the same as that with most steam tramway engines, it was impossible to keep the working parts in order. The dirt from the chimney, although ejected at the rear, was a source of great annoyance, and, with dirty seats, a hot part near the boiler, steam from the glands coming up through the floor, the cost of repairs, and diminishing support, it was found best to discontinue the running. It seems curious that 35 years after the success of Hancock, who had found the means of avoiding nearly all these causes of failure, this experiment should have been so unsuccessfully made.

Hancock's coach, however, for 16 passengers, weighed 3 tons 12 cwt. which is a greater weight per passenger than that of Nairn's Pioneer, and there is little doubt Hancock's coaches were rather noisy and rough riding. His boiler, was, however, better suited to the purpose, the whole of the working parts effectively enclosed, and the greatest trouble was the wear of the tyres of the driving wheels. It is, perhaps, probable, that had Hancock's coaches run a longer time, more troubles would have arisen, the chain he used for driving and the sprocket wheels would probably have worn, but as they were large-featured and strong, they would probably have worn a good deal before needing renewal, and they secured the separation of the engine from, and its higher speed than the driving axle, which was advantageous.

But to return to Thomson's road steamers. The first and leading idea in these was the use of heavy solid india-rubber tyres. The engines using them were mostly fitted with vertical boilers with Field tubes, and with vertical engines, but some of other types were made. They were, however, all of them more of the traction steamer than steam road carriage. They were made by Messrs. Ransome, Sims and Jefferies, Messrs. C. Burrell and Son, Messrs. Robey and Co., and by Messrs. Tennant and Co.

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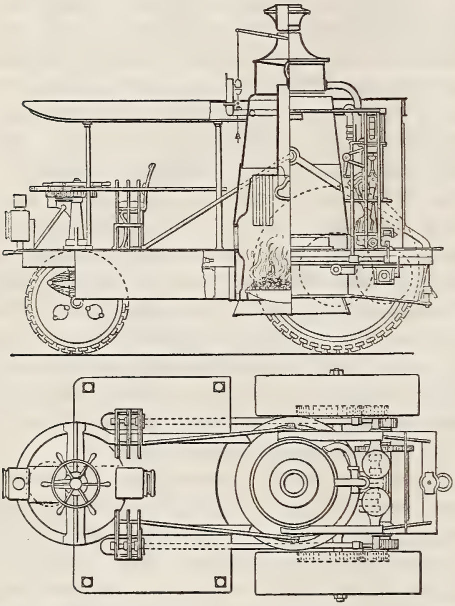
[*] "Improvements in carriage wheels." No. 10990, 10th Dec., 1845.

[†] *The Engineer*, 22nd Nov. 1895, p. 505.

[‡] "Steam Locomotion on Common Roads," J. Head, "Proc. Inst. Civ. Eng.," vol. xxxvi., 1873.

Fig. 28 shows in sectional elevation and in plan the 14 horse-power Thomson's road steamer "Ravee," one of four built by Messrs. Ransome, Sims and Jefferies for the Indian Government in 1871. It had two cylinders, 8 in. diameter and 10 in. stroke, geared both 3·75 to 1 and 12 to 1, to 5 ft. 2 in. driving wheels, fitted with solid rubber tyres 10 in. by 5 in. thick, protected by linked steel shoes. At 150 revolutions per minute the engines gave a speed of ten miles per hour, or of three miles per hour for the slow speed. The boiler was on Olrick's pot Field system with 177 square feet of heating surface and 11 square feet of grate surface. The single leading wheel was also fitted with a rubber tyre, but a double leaf spring was also here used. The engines were used to draw two-wheeled omnibuses carrying 65 passengers and mails between two stations in the Punjab, seventy miles apart. Mr. R. E. Crompton, then Lieut. Crompton, took these engines over and was responsible for their running for some time.*

Fig. 28



Thomson's Road Steamer "Ravee."

Numerous experiments made with engines of this class, fitted with Thomson's wheels, showed that they could haul an unprecedented load in comparison to their own weight, and, correspondingly, could ascend inclines previously insurmountable. Experiments made by (Mr. now Dr.) William Anderson, gave a co-efficient as high as 0·576. A 6-ton engine took a load up an incline of 1 in 9, 20 tons up an incline of 1 in 20, and took itself up a grass slope of 1 in 4·5. A 7-ton engine, with 5·5 tons on the drivers, was tested by drawing a dead weight over a pulley. On good ground, it gave a pull of 63 cwt., giving the co-efficient of 0·576, and it gave a pull of 51 cwt. on a less favourable surface, or a co-efficient of 0·466. These figures were afterwards confirmed by the Royal Agricultural Society trials at Wolverhampton in 1871, when the average co-efficients for iron tyres and rubber tyres were found to be respectively 0·5 and 0·3 on dry macadam roads.

A somewhat similar engine to the Ravee, but named the Sutherland, was tested at the trials mentioned, with results which showed the high tractive efficiency of road steamers fitted with rubber tyres. It was the Ravee which made the longest journey ever made by a self-moving engine, namely, from Ipswich to Edinburgh and back in October, 1871, the engine and carriage it hauled weighing 19 tons.

Messrs. Burrell and Sons made three-wheeled road-engines with Thomson's rubber tyres, locomotive boilers, and with spur gear, as in ordinary road locomotives; and many were sent abroad to haul omnibuses. The cost of renewal of the india-rubber tyres was, however, too great for continued commercial success of the system. A set of three tyres such as those used on the Ravee cost £241. The tyres were loose upon the iron rim, and as this was flanged, the tyre had to be stretched or sprung over the flange to get it on. In working with the heavy weight of these road steamers, the rubber was pressed out as shown in Fig. 29. Under the load the 5 in. tyre was squeezed to 3·25 in., and as the wheel rolled along, not only was the rubber pressed out in advance, but it became closely adherent and stretched tightly on the rear of the wheel, the thickness being reduced by this to 4·5 in. while it resumed its normal thickness in the front. At eight miles an hour the squeezing and stretching of the tyre was such that it left the wheel in the manner shown by a distance of about four inches. From this action the rubber tyre was continuously rotating round the wheel in a reverse direction, making a complete revolution rearwards to every 30 to 40 forward revolutions of the wheel. It will thus be seen that the rubber was very heavily worked and rubbed, and hence gradually reached a condition in which it lost its strength and broke. The linked steel shoes prevented this to a considerable extent, but so strong is the tendency to the creep referred to, that even when the rubber ring was placed between the wheel rim and an iron exterior tyre, on Adams's system, the link connecting the outer tyre to the inner rim was frequently broken, and it was difficult to keep them connected. This was also the case when the rubber was used in blocks.* These facts give some idea of the difficulties connected with the use of solid rubber tyres under heavy loads, and it is rather curious that Thomson, having invented the pneumatic tyre, did not make some efforts to develop it into a form suitable for light road steamers, so as to get some of the spring from compressed air instead of all from soft rubber. With the pneumatic tyre the rubber would not be "worked" so injuriously as in the solid, and the cost would be much less. The insistent load of the Ravee, and such engines, was too great for any solid rubber tyres, except of very large section, and then the expense of the wheel complete was prohibitive. Messrs. Burrell have, however, successfully used such tyres of large width, as will be seen hereafter.

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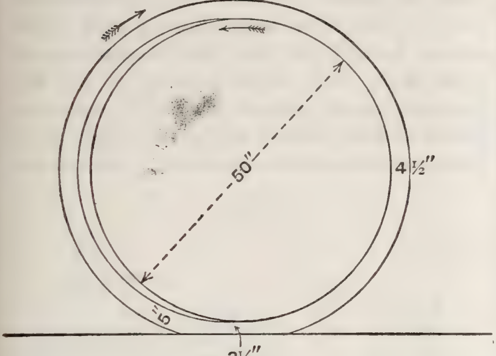
* "Proc. Inst. Mec. Eng." Aug. 1879.

FIG. 29.



THOMSON'S RUBBER TIRE.

It may be remarked, in passing, that although almost innumerable attempts have been made during the past 25 years to produce a satisfactory metallic spring wheel, none have been permanently successful, and the best traction engine wheel to-day is the Boulton wheel, with wood blocks in pockets of the outer tyre. Some of the spring wheels made by Aveling, Fowler, McLaren and Burrell have promised well, but all have in their turn been given up in favour of spring-mounted engines, the best being leaf springs. In running the "Fourgon Postes," between Lyons and Grenoble, doing 500 miles per week, and in high speed traction tram work over long distances with bad roads and no roads, and over the Southern Alps,* Messrs. J. and H. McLaren had unique experiences with spring wheels, springs of all kinds, and rubber springs. In France the whole of the running was done under time penalties, and in all weathers, and all experience went to prove that only leaf springs would stand when rigid wheels were used and that spring wheels were for this heavy work unsatisfactory. In one set of engines rubber buffers were used over the main axles in addition to volute and Timmins's springs, but it was found that the occasional leakage of oil into the rubber buffer-box and the working of the rubber under the load would, after a few days' use, cause the rubber to spue out of the air-hole in the box in the form of rubber ropes. These engines ran for several months, including winter, at from eight to fifteen miles per hour, including the crossing of several spurs of the French Alps with variable gradients including one of 1 in 10. They were fitted with gas head lights and side lamps, each engine carrying a receiver sufficient for the double journey and carrying its own gas-compressing pump. Petroleum lamps were tried, but were frequently put out by the vibration of the engine at the high speed. Much of the experience with these engines was of a nature that would only arise with the heavy form of high speed locomotive, but, on the other hand, many of the lessons learned were not without high value in connection with lighter mechanically-propelled vehicles on common roads.

The same may be said of the very lengthened experiences of Messrs. Burrell and Sons, and reference may be made in particular to a pair of traction engines similar to that shown in Fig. 28, but afterwards fitted with wheels with wide tyres and iron exterior shoes. They were built in 1871 for the Harrogate Gas Company, and one of them is at work to the present time, having been recently replaced by one of Messrs. Burrell's spring-mounted engines weighing 10 tons, and capable of hauling 30 tons. These are fitted with arrangements for three speeds, the highest being obtained by means of a high speed second motion shaft driven by an internal ring of teeth within the fly-wheel rim. A raw-hide pinion is driven by this internal geared fly-wheel, and the shaft which carries it runs with roller bearings. This arrangement is the subject of a new patent, and appears to secure a third speed with very little additional gear. The driving wheels are fitted with rubber tyres, and the boiler is carried over the two front wheels by means of a strong leaf spring of locomotive type. Each of these engines travels 30 miles per day all the year round. The steering is effected by means of a spur wheel on the fore-carriage, into which a pinion on a vertical shaft passing through the smoke-box gears. On the top of this spindle is a worm wheel with a worm worked from the foot-plate. A very rigid steering gear is thus obtained, and one which is certain in its action.

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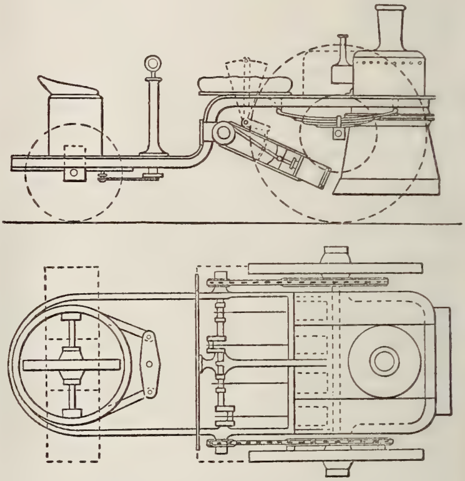
* A large number of different forms of elastic wheels have been made, some of which were described by Head, "Proc. Inst. Civ. Eng.," vol. xxxvi.

* *The New Zealand Farmer*, Sept. 1895, p. 323. "Proc. Inst. Civ. Eng.," paper on "Steam on Common Roads," by J. McLaren, vol. ciii.

All these engines are of what I have termed the steam cart-horse order, and they show the direction in which development has chiefly taken place in the past quarter of a century. The engineers who have been engaged in their construction will perhaps be in the best position for interpreting the experience afforded by this class of road locomotive construction, and no doubt some of them will be early in the field as makers of the light mechanical road carriages for which it is expected there will soon be a considerable demand. The difficulties, however, connected with a radical change in design, in the departure from one line of development to another, are of a kind which are sometimes more easily surmounted by those whose minds are unfettered by a knowledge of all the reasons which have led to adopted forms. The road locomotive builder has had to deal with heavy loads, heavy engines, and with conditions calling for vast strength. He has had to make an engine which is practically unbreakable under the severest conceivable conditions, and it will be easily seen that to turn from this sort of thing to motor carriages in which sufficient strength can be gained with the lightness of the parts of a brougham, on the one hand, or of a street omnibus on the other, will be a mental feat of no small difficulty.

Among the departures from the line of development just referred to, a steam carriage made in 1866-7 by Mr. H. Percy-Holt, may now be described as illustrated by Fig. 30. It is a carriage which contains several features of interest in connection with the construction of a light road vehicle. It was carried on three wheels, the driving wheels being 4ft. 6in. in diameter, and the front wheels 2 ft. 6 in. in diameter. At the rear of the carriage, the frame of which was formed of light angle iron 3 in. by 3 in., was suspended a field boiler 4 ft. in height and 2 ft. in diameter at the upper part, with 50 ft. of heating surface and 3 square feet of grate surface. This supplied steam at a pressure of 250 lbs. to a pair of engines consisting of four cylinders. Each pair of cylinders was 3 in. diameter and 6 in. stroke, the pistons being connected to two separate crankshafts, on the outer ends of which were pitch chain pinions 8 in. in diameter connected to pitch chain wheels, 24 in. in diameter on the drivers by two separate chains. The cylinders were disposed as shown in the plan and at an angle as shown in the elevation, the whole of the machinery being boxed in, including two feed pumps worked direct from the crossheads. The exhaust from the engines passed into a cast-iron box which formed a baffle plate at the bottom of the uptake above the fire where it was superheated. It then issued in five continuous jets up the chimney. This arrangement, owing to the large number of beats from four cylinders, made comparatively little noise. Part of the exhaust was used to heat the feed water when required. The feed

FIG. 30.



HOLT'S STEAM CARRIAGE.

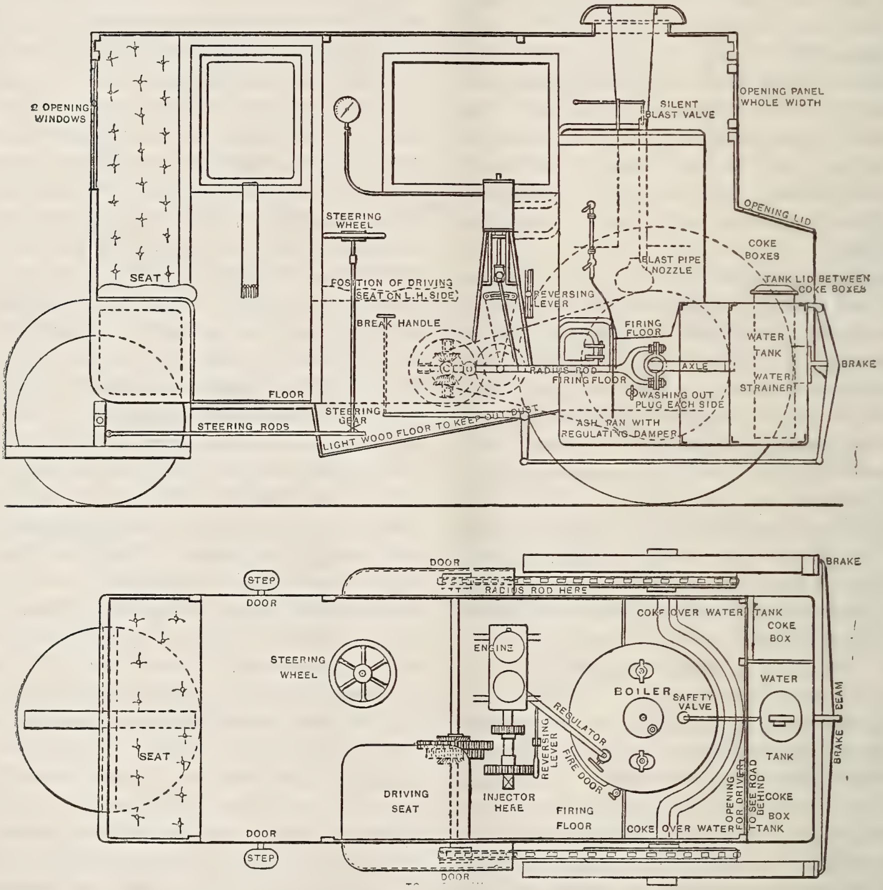
pumps were of novel design, the plunger uncovered a port near the end of its out stroke through which water was admitted from a water tank above it. On the return stroke this suction port was covered by the plunger and the water forced through the delivery valve into the boiler. The carriage complete, weighed, in running order, about 30 cwt. and carried from six to eight people including the steersman and engine and boiler attendant. It ascended gradients of 1 in 14 at about seven miles per hour easily, and on ordinary roads ran from fifteen to twenty miles per hour, and was thus much more powerful than will be required for the moderate speed vehicles of the future. The safety valve used was of the Naylor type, two inches in diameter. The bunkers carried sufficient coke to run about forty miles, and the tanks would hold water for about twenty miles, the coke consumption being about 5 lbs. per miles under favourable conditions.

The steering-wheel was worked by a vertical shaft and cross-bar connected at the bottom of the former by a beam and a pair of rods, connecting it to the table supporting the steering-wheel bearings. The reversing levers for the two pairs of engines could be grasped either separately or together, ordinary link motions being used, working valves in a steam chest between the two cylinders. Each pair of engines, being independent, could be used with the reversing-gear as a brake, and the very great advantage of the independence of these engines was the smoothness with which they suited the speed of the wheels in running round corners and made any form of compensating gear unnecessary. A further advantage was that of being able to use on good level roads only one engine, or to link it up so that very little steam was used. The water-tanks were arranged on each side of the steering-wheel, and the coke-bunkers on either side of the boiler. The greater portion of the weight was carried on the driving wheels, which were of usual omnibus pattern, of wood with 3-inch iron tyres. The chain wheel was fastened to the wood-spokes by clips. The rear part of the carriage was carried on large leaf springs. It was built at Headingly, near Leeds, and used by Mr. Holt for some time.

Another vehicle of very considerable interest now is the steam brougham illustrated by Fig. 31. This was a three-wheeled carriage, built in 1875-6 by Mr. H. A. O. Mackenzie, at the rear of which was a Field boiler with about 34 square feet of heating surface and 1·76 of grate surface; it was 4 ft. high and 2 ft. in diameter. The engine was a two cylinder vertical, driving by one or other of two spur-wheels of different sizes, a second motion shaft in the centre of which was a compensating gear, and on the ends of which were pitch chain pinions, on which, and on toothed rings on the road wheels, ran two pitch chains, the ratio of engine speed to road wheel speed being 6 to 1 and 13 to 1. The driving wheels were 4 ft. in diameter. The boiler pressure was 135 lbs; and, as fuel, foundry coke was used. The boiler was large enough to give considerable reserve capacity, so that on the one hand the water level need not for a few minutes be a cause of anxiety, when road matters were occupying attention, and, on the other, steam did not begin to blow off immediately a stop had to be made. The engine cylinders were 3·75 in. by 4·5 in., and an ordinary link reversing motion was used, with which Mr. Mackenzie used to drive, rather than with the regulator. It was found that one change of speed was sufficient for all purposes, intermediate variations being easily obtained from the engines; and, in fact, Mr. Mackenzie considers that a change gear may be made unnecessary by using cylinders of somewhat larger diameter. For this reason he did not provide any lever arrangement for changing the position of two gear wheels, shown on the crank-shaft, but used simply a broad cylinder of leather, stiffened with $\frac{1}{4}$-inch rods, and encircled by a small buckled strap. When both wheels were out of gear, as shown, this leather cylinder was between them. When either of the wheels was put into gear, this leather collar was taken off, the wheel pushed into gear, and the collar put on behind it. This arrangement was pending experience as to the necessity or otherwise of change of speed by gearing. When the larger wheel on the crank-shaft wa in gear, the speed of the carriage was from 10 to 12 miles an hour. The gear wheels on the counter shaft had wood teeth, to avoid noise, and the driving wheels ran loose on the main axle, which was bent, to escape the boiler, as shown.

The wheels were ordinary wood carriage-wheels with iron tyres. Mr. Mackenzie found the Field boiler very satisfactory, as it gave him plenty of reserve power for emergencies and to meet the varying requirements of the road. The water in passing into the water-tank passed through a strainer, a necessary precaution for a boiler which may have to take water from ponds and streams. The boiler was fed by an injector, which was probably the first so used. The exhaust steam from the engine passed into a cast-iron pot at the bottom of the uptake, from the centre of which issued up the chimney. A blast valve was also used and opened a notch or two when the road did not require a strong blast, the valve acting as a variable blast and enabling the rider to occasionally reduce the back pressure in the cylinders. Radius rods shown in the elevation connected the chain pinion bearings to the axle close to the boss of the driving wheels. These maintained the proper distance between the chain wheels. None of the machinery was visible from the outside, but everything was accessable inside for experimental purposes. The brake tackle was fitted after the carriage was made as it was intended, in the ffrst instance, to brake by means of the reversing lever only. To allow for and compensate for the chain wearing out of pitch, the chain wheel being fitted with teeth as shown in Fig 32. The teeth of the form shown, were held in the toothed ring by a pair of nuts on a screwed stem, and when it became necessary the diameter of the ring was increased by putting thin strips of iron under each tooth as indicated by the dotted lines A.A.

FIG. 31.

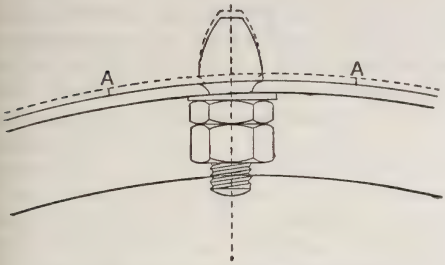


MACKENZIE'S STEAM BROUGHAM.

In the constructor's hands this carriage was found quite satisfactory, but the Road Locomotive Act forced him to discontinue its use.

The carriages by Mr. Holt and by Mr. Mackenzie both present numerous points of considerable interest, but it will be observed that the boiler and machinery are in both cases apparently too much the reason for the existence of the whole vehicle. There is no doubt, however, from what they have done that they would be able to modify their design in accordance with what we may assume to be modern requirements.

FIG. 32.



MACKENZIE'S CHAIN-WHEEL TEETH.

In 1878 a mechanically propelled dog-cart was made by Mr. A. B. Blackburn.* It was propelled by a small three cylinder torpedo engine which drove a transverse second motion shaft placed under the foot-board of the dog-cart, on one end of which was a grooved pulley over which ran a gut belt driving a grooved ring attached to one of the rope-wheels acting as driving-wheel. The torpedo engine and the second motion shaft were fitted with coned pulleys, and a cross-belt upon them enabled the engine to drive the shaft at variable speed. The engine was supplied with steam by a very small coiled tube boiler, described and shown in his specification, and heated by a benzoline burner. The benzoline was led into a vaporiser heated by warmed air, and by the exhaust. The exhaust from the engine passed into a condenser of tubulous form cooled by a fan, the condensed water being forced back into the boiler by a small pump. This dog-cart is said to have worked successfully, but the road locomotive stopped it.

In 1870 Loftus Perkins made what may be called a steam horse, for attachment to the front of any vehicle. In it the engine, boiler and driving-gear were all mounted on circular frame carried above a single wheel, with which all turned in steering, as described in the reference to Fig. 27. The wheel was 25 in. by 12 in., fitted with a Thomson rubber 5 in. by 10 in. The engine was a compound with two cylinders $1\frac{13}{16}$ in. diameter and two $3\frac{1}{8}$ in., all with a stroke of 4 in. He carried a pressure of 450 lbs. in a Perkin's tube boiler, 26 in. high, $15\frac{5}{8}$ in. wide and $20\frac{3}{8}$ in. long. The engine ran at speeds up to 1,000 revolutions per minute, and drove the rubber-tyred wheel by bevil gearing. The weight of the steam horse was 32 cwt. It was sent to Belgium, and its fate is unknown.

The steam from the engines was passed by a pipe to a condenser connected with a water-tank under the vehicle it hauled, which, in Perkins's experiment, was a light van and weighed, with a number of passengers, 57 cwt. A trial run to St. Albans and back gave a coal consumption of 2·17 lbs. per ton mile. The average steam pressure used in its engines was 250 lbs., another average speed was three miles per hour. The grate surface of the boiler was 0·75 square feet. The very high pressure, the kind of boiler, and the very small engines are points of interest. Mr. Perkins also made a tramway engine with his high pressure engine, and a boiler similar to that used in the celebrated yacht *Anthracite*, and with an air-cooled tubulous condenser.

In 1881 Mr. J. G. Inshaw made a four-wheeled steam carriage like a steam Irish car.* It was fitted with a tubular boiler, which supplied steam at 180 to 200 lbs. to two cylinders 4 in. by 8 in. It had three speeds, double driving gear and reversing gear, and weighed 35 cwt. with 10 riders.

Reference should here be made to the electric dog-cart, made in 1888 by Mr. Magnus Volk, of Brighton. In it a small Immisch motor, supplied with current from 16 small E.P.S. accumulators, drove a small second motion shaft under the foot-board by a pitch chain, and from the other end, a chain pinion was connected to a chain wheel on one of the road wheels.†

To several others reference must be made in the next lecture, as well as to the direction which the development of motors has taken. Sufficient has been said to show that, but for some impeding cause, the construction of mechanical road carriages was so far advanced as to have reached the commercial stage. There can be no doubt that the chief hindrance was the existence of the Highways and Locomotives Acts, directed chiefly against the use of traction engines and road locomotives, and even against agricultural locomotives. But the existence of these Acts shows that the country was not alive to any requirements of mechanical carriages, and, with the Acts in force, every attempt was discouraged, and nothing sufficient to encourage the country to demand relief could be done by steam carriage designers.

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* *The Field.* 23rd Nov. 1878, Patent No. 3838 of 1877.

* *The Engineer*, 1st November, 1895, p. 434.

† *The Engineer*, 3rd February, 1888, p. 98.

But we have seen what the Hancock period arrived at, and what the intermediate period, down to 1885, or fifty years, has done. We have seen that whilst British makers have made carriages and worked them successfully abroad, and have made many hundreds of high-speed road locomotives for foreign purchasers, they have been unable to use them in their own country. We have seen that whilst English engineers have paved the way for the construction of steam road carriages, it is not until foreign engineers, taking advantage of their freedom and of our teachings, have begun to reap the harvest we have sown, by the free use of motor carriages, that our country begins to support our engineers. However, it is known now, and the time appears to have arrived when the industrial importance and the useful applications of mechanically propelled road carriages are understood. People now see the necessity for a change in our laws, so that light motors or motor carriages and vans of moderate weights and of moderate speed may be freely used here as they are abroad, and I hope that the necessity for securing the support in Parliament of the proposed Bill for this purpose will be generally realised.

We can hardly say that the small progress made in this country since the time of Hancock was the result altogether of obstruction laws, for the worst features of these laws are comparatively recent. The country was not ready, and our forefathers sought only to establish high speed vehicles. They thus ran counter o powerful interests, and high road speeds were not really wanted then and are not now.

Those who followed have filled up time between the days of absorbing interest in railways and the present by inventions of an important though different kind, and growth of public knowledge of other requirements has at last reached the stage at which the labours of all these workers of sixty years will be more or less utilized. Mechanical road carriages are an admitted necessity and public interest in manufacturing concerns will now encourage builders instead of leaving them single handed to fight through difficulties and unappreciated success as it did Trevithick and others.

Miscellaneous.

CAMPHOR.

In connection with the increased demand and increased price asked for camphor, the *British North Borneo Herald* states that nearly 20 years ago, Formosa camphor was quoted at $20 per picul, but from various causes, chiefly owing to the invention of smokeless gunpowder, in the manufacture of which it is largely used, the price has now risen to $79. Inquiries were made by the Director of Kew-gardens of Sir Frederick Abel respecting the truth of this statement, and the reply is printed in the "Kew-gardens Bulletin." Sir Frederick Abel wrote:—"Any increase of demand, involving a rise in the price of camphor, is not due to its application as a constituent of smokeless powder. That material was used in the earliest days of the manufacture of a successful smokeless powder for artillery and small arms; but its employment was soon demonstrated to be attended with serious practical disadvantages, and its application for this purpose can therefore not be said to have been other than experimental, and of no great importance, even at that time, as effecting the market value of camphor. This substance has, however, been used extensively for many years past, and no doubt in continually increasing quantities, for the conversion of collodion cotton into the material known as celluloid, which is applied to the manufacture of imitation ivory, tortoise-shell, horn, and a great variety of purposes."

SOCIETY OF ARTS EXAMINATIONS, 1896.

SYLLABUS OF THE EXAMINATION IN ECONOMICS.

Examiner.—W. A. S. Hewins, M A., Pembroke College, Oxford; Director of the London School of Economics and Political Science; Dunkin Lecturer on Sociology at Manchester College, Oxford; Member of the Council of the British Economic Association; &c.

1. Candidates for this examination are recommended not to attempt too wide a range of reading, but to lay the foundations of a thorough knowledge of the outlines of economic science. They should, therefore, commence with the careful study of J. S. Mill's *Principles of Political Economy*, or F. A. Walker's *Political Economy*, paying special attention to the objects of the science, the meaning of the terms used, such as *wealth*, *value*, *utility*, *cost of production*, &c.; leading principles, such as the law of diminishing returns, and its relation to the Ricardian theory of rent, the principle of population, the division of labour, &c.; the theory of value, demand and supply, the relation of cost of production to value; the functions of money and credit; the principles which govern the division of the produce into rent, interest, profits, wages, &c. In the appendices to Walker's *Political Economy*, several subjects such as the wages fund theory, taxation, pauperism, &c., are discussed. Having mastered the outlines of the science, the candidate will be in a position (i) to study other works on general economic theory, such as Henry Sidgwick's *Principles of Political Economy* and Marshall's *Principles of Economics*, or the sam author's *Economics of Industry*; or (ii) to devot special attention to one or more branches of the sub

ject, such as may be studied in Walker's *Wages Question*, and the same author's *Money, Trade, and Industry*, Jevons' *Money*, and the same author's *Investigations in Currency and Finance*, Bagehot's *Lombard Street*, &c.

2. Candidates should also, if possible, acquire some knowledge of (i) the history of economic science, and (ii) the history of English industry and commerce. The first of these subjects may be most usefully studied in Ingram's *History of Political Economy* (a reprint of the article "Political Economy" in the *Encyclopædia Britannica*, 9th edition). For the second subject the candidate may study Cunningham and McArthur's *Outlines of Industrial History*. Other works, involving a much longer course of study, are Ashley's *Economic History*, Vol. I., Parts i. and ii.; Cunningham's *Growth of English Industry and Commerce*, Vol. I.—Early and Middle Ages, Vol. II.—Modern Times; Arnold Toynbee's *Industrial Revolution*; Leone Levi's *History of Commerce*.

3. Certificates of three classes will be given, First, Second, and Third. The minimum per-centage of marks for these classes is 75, 50, and 30 respectively. The paper will include questions intended to test the thoroughness of the candidate's knowledge of the outlines of economic theory. Candidates must satisfy the examiner in these questions in order to obtain a certificate. The paper will also contain more advanced questions. In order to obtain a first-class certificate, candidates must satisfy the examiner in these questions also.

4. The Council have accepted the offer of a scholarship made by the London School of Economics and Political Science for the most successful candidate. It will entitle the scholar to a course of training in Economics or Political Science, extending over three years, and to free admission to all the lectures, &c., arranged at the school during that period.

This examination will be held on Thursday, 26th March 1896.

SYLLABUS OF THE EXAMINATION IN PRÉCIS-WRITING.

Examiner.—S. C. Paul.

Candidates will be furnished with a printed copy of correspondence (usually on some subject of general public interest), and will be required

(1) To make a short Abstract, Schedule, or Docket of the several letters or other papers;

(2) To draw up a Memorandum or Précis, *i.e.*, a brief and clear statement of what passed, not letter by letter, but in the form of a narrative.

No candidate can expect to obtain either a Second-class or a First-class Certificate who does not attempt the Memorandum or Précis as well as the Abstract, and no candidate can expect to obtain a First-class Certificate who does not produce a fairly good Memorandum.

The object of the Abstract, Schedule, or Docket is to serve as an Index. It should contain the date of each letter, the names of the persons by whom and to whom it was written, and, in as few words as possible, the subject of it. The merits of such an Abstract are—(*a*) to give the really important point or points of each letter, omitting everything else; (*b*) to do this briefly; (*c*) distinctly; and (*d*) in such a form as to readily catch the eye.

Clear and neat handwriting, and clearness and conciseness of expression, are essential to success. Specimens of the manner in which the substance of letters should be set forth in an abstract of this kind may be found in the Tables of Contents, which are prefixed to the following Parliamentary publications, viz., "Railways—Workwomen's Trains on the Metropolitan Lines—C. 7657.—1895." Price 2d., and "Africa No. 4, 1895.—C. 7646." Price 3d. These publications may be purchased, either directly or through any bookseller, from Messrs. Eyre and Spottiswoode, East Harding-street, Fleet-street, E.C. Neither of them will be set at the examination.

The object of the Memorandum or Précis—which should be drawn up, not letter by letter, but in the form of a narrative—is to inform anyone who has not had time to read the original letters of all the leading features of what transpired as shown by the correspondence. It may be assumed that the person for whose benefit the Précis is prepared has some general knowledge of the subject to which it relates, but that he desires to be reminded of the circumstances which immediately gave rise to the correspondence, and to be put in possession of the salient and material points thereof.

The merits of such a Précis are—(*a*) to contain all that is important in the correspondence, and nothing that is unimportant; (*b*) to present this in a consecutive and readable shape, expressed as distinctly as possible, and as briefly as is compatible with completeness and distinctness.

GLASS BEAD-MAKING IN VENICE.

The Chinese are said to be the oldest bead makers in the world; they have made beads so long that their historians do not mention a time when their industry was not ancient, and the Chinese to-day do the work just as their forefathers did, and the styles are the same. "Kuhlow's German Trade Review" says that after the Chinese, no people are so expert as the Venetians. At present there are more than one thousand workmen in the island of Murano alone who are engaged in bead-making. The few manufacturers in other parts of the world have all learned the secret of the craft in Venice. For bead-making there must be a rope walk connected with the glass factory. A rope walk is a narrow stright gallery about 150 feet long, and so situated that the middle is not far from the furnaces in which the glass is melted. The first process is the making of ordinary tubes. Two workmen seize a huge wedge of the "metal," as the molten glass is called, between their blowpipes, and after it has been blown hollow, they gradually stretch it out into a long swinging rope. When it has been reduced to the proper size for the beads about to be made, it is laid away to cool, after which a workman, in a wonderfully deft manner, chips it into fragments of uniform size. Often for small beads these are not much larger than a grain of wheat, but so carefully is the work done that the little cylinders are rarely cracked or spoiled. The pieces are now picked up by boys and placed in a tube with sand and ashes and stirred up carefully. In this way the holes in the embryo beads are stuffed full, thus preventing the danger of the sides flattening together when heat is applied. They are next placed in a skillet and stirred over a very hot fire until the ragged edges where the pieces were broken from the tubes are rounded, giving the beads a globular form. As soon as they are cool, the ashes and sand are shaken out of them in a sieve, and they are then separated according to size by means of other sieves. They are next taken to a long table around which boys and girls are sitting. If the glass is coloured, as it often is, the piles of beads on the table exhibit every hue, from jet black, through red, green, yellow, and blue, to white. Each child has a needle and thread, and, by long practice, the beads are placed on strings with inconceivable swiftness. The children also keep a correct count, so that the manufacturer knows exactly how many beads he is sending out. The threads are then tied into bundles.

PAPER SAILS.

According to the *Handels Museum*, sails prepared from paper are now used in the United States for yachts and cutters to a considerable extent, and they have also been successfully applied to larger vessels. They are much cheaper than canvas sails, and it is affirmed that by special treatment of the materials they can be made as soft, flexible, and untearable. Bichromate of potassium, glue, alum, a solution of alkaline silicate and fat are added to the paper pulp, and a fairly thick paper is produced from this by means of a paper-making machine. Two strips of this are then pasted together, and passed through rollers under considerable pressure, the paper then being in the form of very thin, soft sheets. It is then passed, in an endless roll, through a weak solution of sulphuric acid, which converts the upper surface into a kind of parchment. The subsequent processes are washing with soda solution, drying and glazing. In the manufacture care is taken, when the strips of paper are fastened together, to leave the edges free, so that other strips can be added at the sides, and a sufficient breadth for sails thus formed. The paste which is used for fastening the strips together, contains the same ingredients as those added to the paper pulp. The edging of the sail is formed by inserting cords or ribbons at the sides.

Notes on Books.

Patent Laws of All Countries. By W. Lloyd Wise. London: Cassell and Co., Limited. 1895.

This is a reprint of articles on the Patent Laws of various countries which have already appeared in a periodical. The work is not yet complete, for though the countries are arranged alphabetically the last given is Germany. But the information in those countries which have already been dealt with (and these including the colonies amount to about 23) seems to be very complete. In addition to information on such heads as—Who may obtain a patent, subject matter, procedure, rules as to working, fees, assignment, and transfer, &c., there is in the case of each country a miscellaneous section in which information is given as to area, population, productions and industries of the country in question.

Etching, Drypoint, Mezzotint. By Hugh Paton. London: Raithby, Lawrence, and Co., Limited. 1895.

This book is somewhat on the same lines as the practical portion of the late Mr. Hamerton's well-known work on "Etchers and Etching." It gives minute practical information as to the tools, appliances, materials, and methods employed, and as to the way of using them, and the different descriptions of etching and mezzotint. The work is fully illustrated with examples of results by the various processes, and in one case, that of ordinary etching with the nitric acid mordant, two states are given, a first proof, and a second proof after the plate has been re-grounded and completed. The illustrations are all the work of the author, Mr. Paton, and he does not spare ctiticism of his own efforts, in some cases even leaving slight mistakes and undesirable effects for the purpose of pointiug them out and showing how they ought to be avoided. The instructions given are so complete that anyone with the necessary capacity for drawing and sufficient handiness to deal with the tools and materials will find sufficient information to enable him to take up the art.

Obituary.

Sir Edward Harland, Bart., M.P.—Sir Edward James Harland, who died suddenly on Tuesday, 24th ult., at his residence Glenfarne-hall, Enniskillen, was elected a member of the Society of Arts in 1892, and in the same year was chosen by the

Council one of the extra Vice-Presidents, elected in accordance with a special bye-law passed for the purposes of the Royal Commission for the Chicago Exhibition. He was the son of William Harland, M.D., of Scarborough, and was born 15th May, 1831. He went to Belfast 41 years ago, as the manager of the then small shipyard on Queen's Island. The famous "White Star" liners, constructed by him and his firm, were first designed by himself, on the model of a fish swimming through the water. Sir Edward Harland was for several years Chairman of Belfast Harbour Board, and was Mayor of Belfast during the visit of the Prince and Princess of Wales in 1855; he was re-elected in the following year. In 1889 he was elected M.P. for the Northern Division of Belfast, and continued to hold the seat until his death.

General Notes.

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DRESDEN EXHIBITION, 1897.—The Department of Science and Art has received, through the Foreign Office, a despatch from the German Ambassador at this Court, calling attention to an International Art Exhibition proposed to be held at Dresden in May—October, 1897, to consist of collections of works from different countries, and to comprise works of painting, sculpture, and architecture, and of the delineating and multiplying arts, which have been produced during the last ten years.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

JANUARY 15.—"The Making of a Great University for London." By PROF. SILVANUS P. THOMPSON, D.Sc., F.R.S.

JANUARY 22.—"Supply of Sea-water to London." By FRANK W. GRIERSON.

JANUARY 29.—"Standards of Light." By W. J. DIBDIN, F.C.S. CAPTAIN W. de W. ABNEY, C.B., F.R.S., will preside.

FEBRUARY 5.—"The Mexican Drainage Canal." By FREDERICK HENRY CHEESEWRIGHT, M.Inst.C.E.

Papers for evenings, the dates of which are not yet fixed :—

"Dairy Produce." By GEORGE BARHAM.

"Some Native Irish Industries." By PROF. HADDON.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Musical Pitch." By A. J. HIPKINS.

"Report of the Royal Commission on Secondary Education." By H. MACAN.

"Water Purification by means of Iron." By F. A. ANDERSON.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock :—

JANUARY 16, at 4.30.—"The Shan Hills: their Peoples and Products." By COLONEL R. G. WOODTHORPE, C.B., R.E., Indian Survey Department. The Right Hon. GEORGE N. CURZON, M.P., will preside.

FEBRUARY 13, at 4.30.—"Punjab Irrigation—Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

FEBRUARY 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. TRIPP, formerly of Sumatra.

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E.

APRIL 23, at 4.30.—"The Deserted City of Hampi." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of January 16, February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

JANUARY 14.—"The Poster, and its Artistic Possibilities." By GLEESON WHITE.

FEBRUARY 4.—"The Garden in Relation to the House." By F. INIGO THOMAS.

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S.

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

JANUARY 28.—"Stamboul: Old and New." By RICHARD DAVEY.

FEBRUARY 18.—"Recent Developments in

"Electrical Enterprise in America." By G. F. PARSHALL (General Electric Company, U.S.A.).

MARCH 17.—

APRIL 21. — "Madagascar." By CAPTAIN PASFIELD OLIVER.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.

JANUARY 20.—LECTURE I.—*The Action of the Transformer.*—Real and imaginary transformers—Transformer diagrams — Alternate current curve tracing—Various forms of curve tracers—Discussion of transformer diagrams—The harmonic analysis of diagrams—The curves of induction and hysteresis—Magnetic leakage—Core and copper losses—Effect of variation of form of the electromotive force curve on core losses—Variation of core losses with temperature—The power factor.

JANUARY 27.—LECTURE II.—*The Construction of the Transformer.*—The core—Sheet-iron stampings—Building the core—Prevention of core losses—Selection of iron—The coils—Coil winding—Insulation of coils and core—The case—Ventilation and surface radiation — The terminals — Primary and secondary fuses and switches—Sizes and forms of transformers in practice—Open and closed circuit transformers.

FEBRUARY 3.—LECTURE III.—*The Testing of Transformers.*—The measurement of the power taken up in an inductive circuit—The theory of the wattmeter—The construction and use of the alternate current wattmeter—Various methods of measuring alternating current power—The testing of transformers—Testing by curve tracing—Testing by the wattmeter—Differential testing—Practical tests in the sub-station and workshop efficiency curves—Core losses for various sized transformers—Specifications for transformers—Measurement of copper losses and drop—Iron testing.

FEBRUARY 10.—LECTURE IV.—*The Employment of the Transformer.*—Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs or alternating current stations—Conclusion.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.

February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.

March 9, 16, 23.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.

April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.

April 27, May 4, 11, 18.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 6......Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Watson Smith, "A Technological Study of Comparative Affinities in the case of certain Salts of Ammonia." 2. Mr. J. W. Lovibond, "Colour Effect of Lime Salts on Hops in Brewing."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. Punchard's Paper, "The Working of the Agricultural Holdings Act, 1883."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. Donaldson Smith, "A Journey through Somaliland."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Israel Gollancz, "Schoolmasters and Plays."

TUESDAY, JAN. 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Prof. J. G. McKendrick, "Sound, Hearing, and Speech." (Lecture V.)

Pathological, 20, Hanover-square, W., 8½ p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, JAN. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lectures.) Prof. John Milne, "Earthquakes and Volcanoes." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Messrs. A. J. Jukes-Browne and William Hill, "A Description of the Cenomanian in Western France and the South-West of England." 2. Miss G. L. Elles and Miss M. R. Wood, "The Llandovery and Associated Rocks of Conway." 3. Mr. A. T. Metcalfe, "The Gypsum Deposits of Nottinghamshire and Derbyshire."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, JAN. 9...Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Prof. Mahaffy, "The Macedonians in Egypt."

Royal Institution, Albemarle - street, W., 3 p.m. (Juvenile Lectures.) Prof. J. G. McKendrick, "Sound, Hearing, and Speech." (Lecture VI.)

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 10...Astronomical, Burlington - house, W., 8 p.m.

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Professor T. Hudson Beare, "Problems connected with the "Working and Testing of Gas-engines and Hot-air Motors."

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, JAN. 11...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

CORRECTION.—Page 82, col. 2, lines 3[illegible] and 45, Mr. F. W. Lewis writes that the average per hour should be 6,000 instead of 1,600.

Journal of the Society of Arts.

No. 2,251. Vol. XLIV.

FRIDAY, JANUARY 10, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

Prof. John Milne, F.R.S., delivered the second and concluding lecture of his course on "Earthquakes, Earth Movements, and Volcanoes," on Wednesday evening, 8th inst. After recapitulating some of the points made in the first lecture, Professor Milne referred to the supposed possibility of predicting the coming of earthquakes. Those predictions which came true were, most probably, nothing more than happy guesses. As there were in Japan some 1,000 earthquakes in the year, or an average of about three a day, it would be strange if a few of the predictions did not come true. He then referred to the diurnal movements of the earth, and pointed out that the expression, *terra firma*, was a peculiarly inappropriate one.

A series of lantern slides were then shown which illustrated the effects of earthquakes on railways, bridges, arches, buildings, &c.

Fractures were usually found at the base of columns, so that an attempt had been made to increase their strength at the base, and a special style of building was coming into use, which it was thought might be protective against the dangers of earthquakes. A picture of a large cotton mill in Japan, built on the English plan, was shown. This had been destroyed in an earthquake, and it was not likely that so high a building would ever be erected again in Japan.

In one earthquake nearly 10,000 persons had been killed, and $30,000,000 lost, so that it was necessary to attempt a style of building which might be found to be earthquake proof. The lecturer concluded by showing a series of curves obtained by the use of an instrument intended to record the vibrations caused by the passing of trains over bridges, and various kinds of ground, by means of which faults of construction could be discovered.

The Chairman (Mr. Francis Cobb) moved a cordial vote of thanks to Prof. Milne for his interesting lectures, which was carried unanimously.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1896.

The prize is offered to the student who obtains the highest awards in the following subjects:—

(*a*.) A finished drawing of imperial size from the nude living model.

(*b*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c*.) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d*.) Drawing from the life done at the Examination on May 2, 1896.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892 or in 1893 cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art in April, 1896. Each competing drawing must be marked, "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Proceedings of the Society.

CANTOR LECTURES.

By W. Worby Beaumont, M.Inst.C.E.

Lecture III.—Delivered December 16.

Whatever the cause of the rekindled interest in mechanical road carriages, it must be admitted that the widely spread popular feeling in their favour is due to the development which has taken place in their construction and use in France and Germany. In these countries there are several hundreds of them in use for almost every purpose. It is quite probable, however, that this fact would not have been placed prominently before the British public for some time had not the enterprising proprietors of the *Petit Journal* offered the substantial prizes for which several makers and many vehicles competed* in July, 1894, and in July of this year. The trials of vehicles last year may be looked upon as dress rehearsals of the long journey Paris and Bordeaux trials, which took place* in July of this year, and attracted, as races always do in every country, so much attention. Not only did these competitions show the practical possibility of these motor carriages for all purposes, but through them it became known in the United Kingdom that a considerable industry in their manufacture had already come into existence on the continent. From these foreign manufacturers, two at least of these carriages were brought and used in this country, so that it became obvious that a source of industrial occupation in providing a much needed means of transport was not only being neglected in this country, but was being encouraged to our disadvantage by our neighbours across the channel. The proprietors of *The Engineer*, seeing the possible importance of motor carriage manufacture, immediately decided to take some steps to encourage British manufacturers to occupy the field which otherwise would be left to foreign enterprise, and they, as is now well known, offered 1,000 guineas in prizes for the best motor carriages for several purposes.

It is, however, useless to build carriages which our laws will not allow us to use, and they, therefore, took steps to ascertain the feeling of the country on this subject, and to memorialise Parliament with a view to obtaining for British engineers and motor carriage builders, and for British people, that freedom for the use of mechanically propelled vehicles which is now enjoyed by all those who use horse hauled carriages. In this work *The Engineer* is being supported by the Self-propelled Traffic Association, which, under the leadership of Sir David Salomon, was inaugurated last week. Steps are also being taken by influential people in several towns to secure that attention to the subject which is necessary to obtain its immediate consideration in Parliament. The Birmingham City Council, at the suggestion of Councillor R. F. Martineau, will probably present a petition to Parliament on the part of their city.

The patience of British people under legal restrictions is proverbial, and this patience has been tried to the utmost with respect to road locomotives. Much of the work of agriculture and of several other industries would now be impossible but by the aid of road locomotives, and yet, in spite of the necessity for the relief of agricultural burdens in every reasonable manner, the farmer and the traction engine owner can only work these engines under restrictions and fines, and licenses, and regulations which make us a laughing stock in every other country.*

I am not, however, now concerned with

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* *The Engineer*, 20th and 27th July, 1894, pp. 47 and 86.

* *The Engineer*, 12th July, 1895, p. 36.

* Much of the objection to traction engines would be removed if all the makers and users would case in the fly-wheel and working parts.

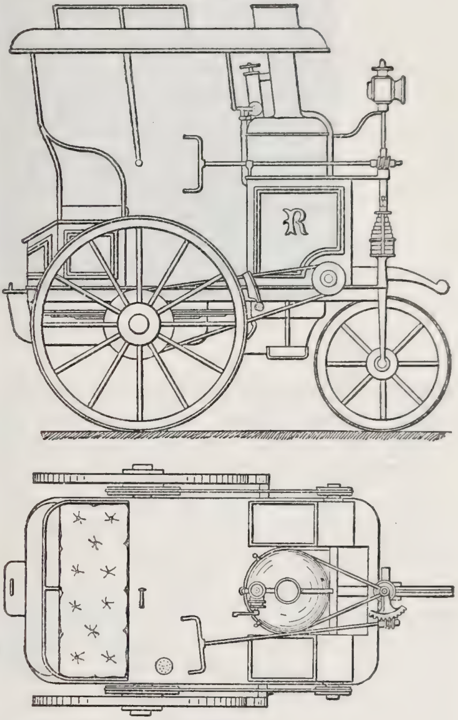
these road locomotives except in so far as the Acts under which their use is regulated are the Acts which prevent the use of any mechanically propelled vehicles of any kind on the thousands of miles of beautiful roads in the United Kingdom. If a man runs a tricycle with however small an electric motor for occasional assistance, he must abide by this law relating to 10 ton locomotives. The absurdity of the position is almost incredible, and surely English people need only to be reminded of it to insist upon a change consistent with prudence and common sense. I am bound to add one word more on this part of my subject. These laws, which we patiently bear, have driven from British works and British workmen the industry which now ought to be ours, but which is French and German. We could not to-day buy a British motor carriage if we would give for it its weight in gold, although it is British engineers who have shown the way to make them,

The manufacture of motor carriages may become a great industry, greater even than the cycle industry, if English people will be true to their own interests and let Parliament know that it is their will that the motor carriage shall be as free as horse carriages.

I have already shown that Englishmen, fifty-five to sixty years ago, proved with complete practical sufficiency that steam road carriages might be a commercial success. Between that time and the present, men of the United Kingdom have from time to time shown how to make steam, electrical, and oil motor carriages. They have all along been first in design and first in enterprise, but they have lived in an age and in a country which, although always grateful, prefers to postpone the recognition of genius to posthumous honour, rather than permit the most beneficial infraction of an anachronistic law. These pioneers have been, as they must be, enthusiasts on the subject, or amateurs, or both. No others would work in the development of a new thing which the laws discountenance and forbid. They generally outdistance those whom they would lead, and achieve the distinction of men ahead of time. This generally is the utmost of their consolation, but fortunately some of those who have been leaders in motor carriage construction are with us now, and we may hope they will, after all, be in at the finish.

I have time for only one or two proofs of this beside those I have already mentioned. The steam carriage shown by Fig. 33 was made by Mr. Leonard J. Todd in 1870. This carriage was 8 ft. 6 in. long, 4 ft. 6 in. wide. It ran on three wheels, the driver's being 4 ft. 6 in. and the leading steering wheel 2 ft., all ordinary carriage wheels. The engine consisted of two vertical cylinders, 2½ in. diameter and 4 in. stroke, each contained in a box in front of a coal bunker on either side. They were completely protected, and each separately drove a driving-wheel by means of a half inch gut belt running on a loose cone, so that the carriage could be readily steered in any direction. The steam exhaust from the two tiny cylinders was so small in quantity as to be almost inappreciable. The boiler was 16 in. diameter, 3 ft. 9 in. high, and contained a large number of Field tubes, 1 in. diameter, the heating surface being 16 ft., and the grate surface 0·75 ft. The carriage carried two persons, was a practical success, and many would have been made but for the road locomotive Acts, Mr. Todd having received numerous orders and inquiries for them.

Fig. 33.



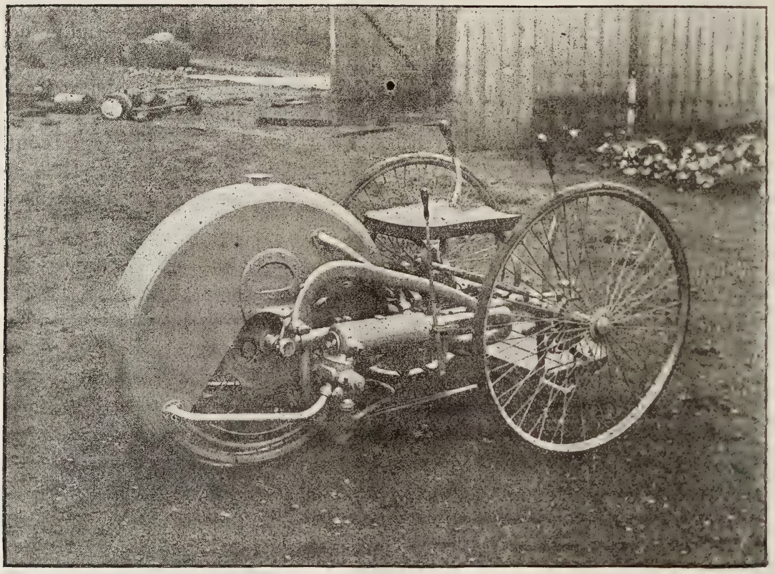
Todd's Steam Carriage.

Up to this point I have not been able to speak—with the slight exception of the electrical dog-cart made by Mr. Magnus Volk, of Brighton, and of the steam dog-cart made by

Mr. Blackburn—of Englishmen being first with reference to any but steam vehicles, but I have now to mention a vehicle with which an Englishman was first—in the construction of a motor carriage, in which an oil-engine was the form of motive power used.

The motor tricycle shown by Fig. 34 is an oil motor cycle made in 1883, improved and exhibited in the Inventions Exhibition, in 1885, by Mr. Edward Butler, who has since made several oil engines. He gave up motor carriages because the 1878 Road Locomotive Act would not allow them to be used. Detail drawings of this motor were exhibited at the Stanley Cycle Show in 1884, and, as improved, at the Inventions Exhibition of 1885. As at first made, this motor had double-acting cylinders coupled direct to the single driving-wheel, but the two pairs of valves were not satisfactory, and the ignition by a magneto machine was unsatisfactory, especially when only from 50 to 80 revolutions per minute were being made. Subsequently a Vass-Varley influence machine was used, and afterwards an ordinary bichromate battery with a sparking coil. The cylinders, which were 2½ in. diameter and 8-in. stroke, altered from double to single acting, and the stroke reduced to 5·in.; and instead of driving direct, were coupled through epicyclic gearing, with a ratio of 1 to 6.

Fig. 34.



Butler's Oil-Engine Tricycle, 1895.

A hollow guard covered the back wheel and fly wheel, and was used as a water-cooler—the wheel it covered acted as a fan. This cooler was, I am informed, more than sufficient to keep the cylinders from overheating. The pipes to and from it are seen in Fig. 34.

The mixture of benzoline and air, formed by an inspirator,* was similar to that used with Mr. Butler's domestic motor, and gave no trouble.

The framing was oval sectioned hollow steel and very strong; the wheels 32 in. in diameter, with 1¼-in. solid rubber tyres on the forward wheels, and 1½-in. on the rear driving-wheel.

The steerage was by two vertical handles, which controlled the two front wheels, their axles being pivoted at a short radius and connected by a rod, arranged to give each wheel its proper relative angle in steering. This steerage was quite open in front and very easy. Each forward wheel was fitted with a hand-brake, applied by a foot lever. The action of the brakes did not interfere with the steering.

In place of clutches or disengaging gear for stopping and starting, a pair of small wheels were arranged to be pressed on the ground by a foot lever toggle motion, so as to lift the driving-wheel off the ground; this, in practice was easily done, and was, I am informed, simple and satisfactory.

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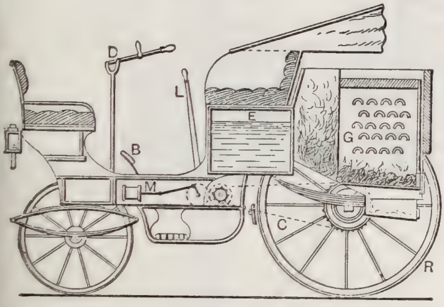
* *The Engineer*, vol. lxx., p. 65.

Fig. 34 shows this lifting gear for stopping and starting, and the steering handles and method of attachment to the axles of the steering wheels. The cylinders were made of phosphor bronze, and designed with the large hollow bent connecting rod to work with an explosion at each stroke. If it had been originally designed with single acting cylinders and gear, the arrangement of the cylinders would have been neater and the connecting rods of the ordinary straight instead of the curved forms shown. The machine is still in existence. Its weight is 300 lbs.; 10 pints of benzoline and 4 gallons of water can be carried, making 350 lbs. ready for travelling.

In about the year 1889, M. Serpollet invented the boiler known by his name. It is a capillary water-tube boiler, the tubes of which were, as first made, closed up by flattening, so that there was scarcely any passage for water. The tubes were subsequently made of the crescent form (Fig. 36), and were encased in cast-iron by casting them in. It is an instantaneous generation boiler, into which the feed water is forced as steam is required. The boiler was exhibited at the Paris Exhibition in 1889, and has since been used for various purposes, including steam tricycles and carriages, by M. Serpollet and others.[*]

In the boiler of the carriage shown in Fig. 35, a pressure of about 300 lbs. is carried.

FIG. 35.

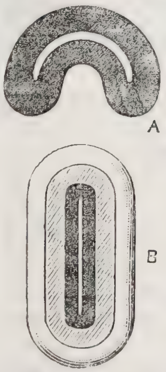


SERPOLLET STEAM CARRIAGE.

The engine consists of a pair of horizontal cylinders, $2\frac{1}{2}$ inches in diameter, and $2\frac{1}{4}$ inches stroke, the crank-shaft being connected to the driving wheels by means of pitch chains. The exhaust steam passes into the chamber above the fire space, and so passes away into the chimney in a superheated condition, so that it is generally invisible, the discharge taking place beneath the carriage. The coke storage is sufficient for a journey, under good conditions, of 40 miles, but the water tank has to be refilled several times in that distance. The pump used for supplying the boiler is of about 1 in. in diameter, and of very short stroke, about three-quarters of an inch.

Fig. 36 shows the construction of the engine as used by M. Serpollet. The pistons of the two cylinders are connected to two cranks on a crank-shaft, which, by one pinion, conveys motion to a second motion shaft, on which is a compensating motion gear. On the ends of this are ten tooth chain pinions for the pitch chain, by which the road wheels are driven.[*] It must be understood that it is an instantaneous generation boiler, the tubes being capable of withstanding the heat of the furnace whether there is water in them or not, so that the question of regulation is got over by the water only being admitted to these tubes when the engine wants steam, or, in other words, when the engines are at work. That gets over one of the greatest difficulties with reference to the use of steam for road carriages. The boilers for fixed engine are made on the same principle, but to prolong the life of the tube and to improve the action of the boiler on the instantaneous system, is cast into a surrounding of cast-iron, so that the tube itself, which has to stand the pressure, and which receives the heat, is protected by a very large heat-regulating medium.

FIG. 36.



SERPOLLET BOILER TUBE, &c.

The tube used in motor carriage boilers is of the section shown at A, Fig. 36, and that used as cast into a cast-iron surrounding is shown at B. Mr. Bryan Donkin had one of the Serpollet carriages in London, and made numerous experiments with it about four years ago. The steering is effected by a hand lever and connecting rods, which control the short-joints shown in Fig. 37 (page 154) and Fig. 43 (page 158), each short axle at the end of the main fixed, fore axle moving independently, as on Akerman's system of carriage axles, invented and used in 1819.

A small oil motor carriage has been made by Mr. J. H. Knight, of Farnham. It is a three-wheeled vehicle, one of the hind wheels—which are 3 feet in diameter—being a driver. The engine consists of a single cylinder of $3\frac{1}{4}$-in. diameter and $4\frac{1}{2}$-in. stroke, capable of giving $\frac{3}{4}$ B.H.P. at 500 revolutions per minute. The arrangement of the gear included two speeds brought into use by means of ropes running on grooved pulleys, with a pair of jockey pulleys to put the one or the other into action, giving a speed of from about $3\frac{1}{2}$ to about $7\frac{1}{2}$ miles per hour.* The engine drives from the crank-shaft to an intermediate shaft by the ropes mentioned, and the latter drives the road wheel by means of a pitched chain. The engine was, at first, made to run with benzoline, but Mr. Knight now informe me that he is successfully running it with ordinary lamp petroleum. The weight of the carriage as shown, capable of carrying two persons, is 575 lbs. It was built as an experiment; and as Mr. Knight has already succeeded in using oil of a high flash point, he has experimented to some advantage.

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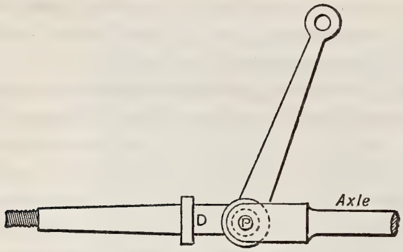
[*] *The Engineer*, vol. lxxii. p. 26, 27th Sept., 1895, p. 314, and 25th Oct., 1895.

[*] *Engineering*, 18th Oct., 1895, p. 499.

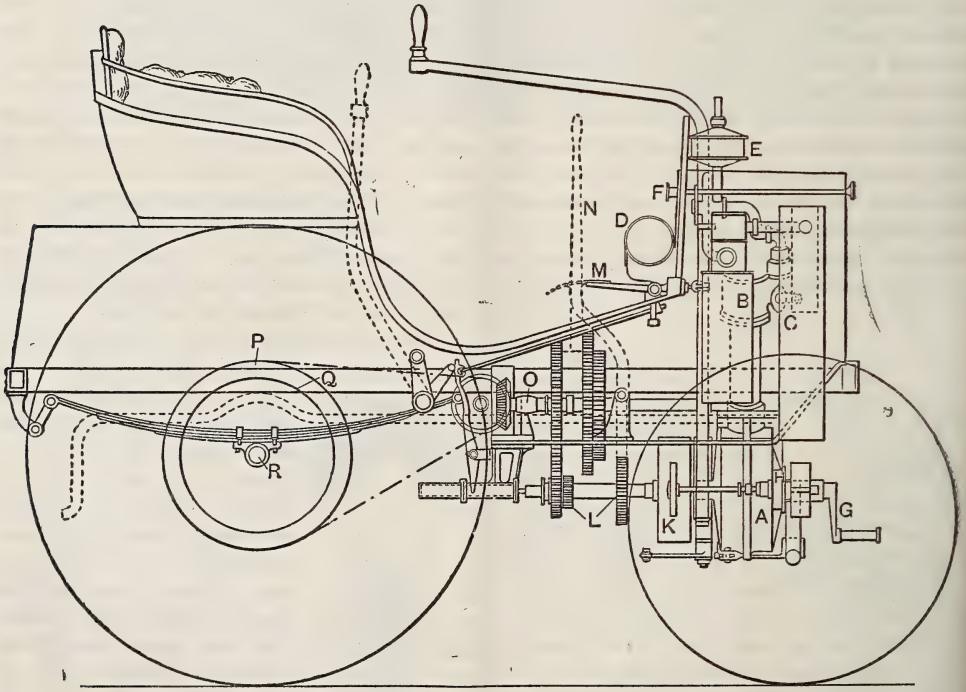
FIG. 37.



STEERING AXLE, SERPOLLET CARRIAGE.

The carriage next to be described is that which received the second prize in the Paris and Bordeaux race organised by the *Petit Journal* last July. It performed the journey in the shortest time, but as it only carried two persons, it was not awarded the first prize. The carriages are made in several forms, one of the best being the form purchased and used by the Hon. Evelyn Ellis. The arrangement of the gear is seen in Fig. 38. The engine employed, like that of so many of the French carriages, is the Daimler motor, a well-known vertical engine, running at a high speed and using benzoline. It has two cylinders, set at an angle of about 15°, and coupled to a crank partly formed by a pair of fly-wheel discs. This motor is entirely enclosed in a box, which also contains the vapouriser, B, and an exhaust box, C. The reservoir for carrying the benzoline is seen at D. At E is the regulator for controlling the

FIG. 38.



PANHARD AND LE VASSOR'S DAIMLER MOTOR CARRIAGE.

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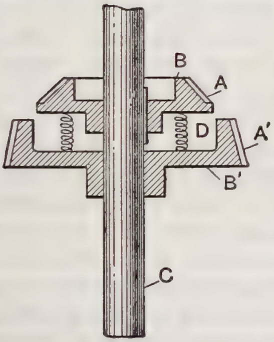
* *The Engineer*, 13th September, 1895, p. 252.

supply of benzoline to burners for heating the ignition tubes. At H is a small centrifugal pump driven by a belt on the pulley, J, for circulating the water round the cylinder jackets. Gearing is arranged for three different speeds, the cog-wheels, L, being made of gun metal, and moveable so that they may either of them be made to engage with the three wheels above them, they are made tight or loose upon the crank-shaft by means of friction clutches at K. The intermediate shaft driven by this gear conveys motion by another intermediate shaft, placed transversely across the carriage, and carrying a pair of pitch chain pinions which drive the road wheels by a pitch chain on sprocket wheels attached to their spokes. A differential or compensating motion is fitted to the transverse intermediate shaft. To alter the speed while the engine is running the pedal, M, is depressed, and the gearing then brought to rest by means of the lever, N. The change in the position of the gear wheels is then made, the cogs all being rounded at their corners to enable them to find their way into the corresponding teeth of the upper wheels.

A pulley, Q, is placed upon the driving wheels, and used for carrying a brake instead of putting a brake on the tyres of the road wheels.

The clutch already referred to is shown by Fig. 39. The shaft, C, is the crank-shaft,

FIG. 39.

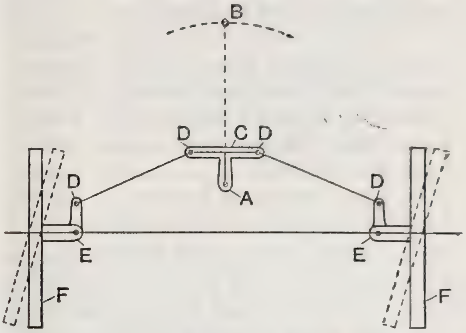


PANHARD AND LEVASSOR FRICTION CLUTCH.

upon which is fixed the coned disc, B. In ront of this and sliding upon a feather is another friction cone, the face of which has a greater angle. When the containing or inerior cone disc which encircles these, is pushed against these inner cones, the smaller one etires into the larger one against the resistance of the springs, D, and when the frictional contact due to this resistance is reached, the further frictional contact and more powerful grip of the disc, B′, is obtained, the object being as far as frictional cone clutches makes it possible to put the carriage gradually into motion, the faces of the cones B and B′ are coated with leather at A and A′.

The steering is effected by means of front wheels running on short axles, as seen in the diagram, Fig. 40. The system, it may be mentioned, is that of Ackerman, already referred to. F F are the steering wheels, with axles pivotted at E, and operated by rods from the steering lever at D. This form of steering gear removes some of the difficulties connected with a straight axle and fore-carriage of the ordinary kind, and it, moreover, secures good control and steady movement.

FIG. 40.



PANHARD AND LE VASSOR STEERING GEAR.

The Daimler motor,* to which reference has already been made, as seen in Fig. 38, is used by several of the Continental firms of builders of motor carriages. Quite recently it has been much modified, and takes the form which will be referred to hereafter in connection with the Daimler carriage.

The carriages built by Messrs. Peugeot Frères are of several forms, and all are driven like those driven by Messrs. Panhard and Levassor, by Daimler motors—generally, however, placed at the rear instead of the front of the vehicle. The vehicle is similar to that purchased by Sir David Salomon. This change in the position of the engine makes no material difference in the mechanism of transmission. The differential motion with its connected gear is utilised as a means of reversing the direction of motion of the carriage, which weighs about 16 cwt., and carries four persons.

This carriage took the first prize, as,

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* *The Engineer*, vol. lxxv., p. 322.

although it came in second from Bordeaux, it conformed to a condition expressing preference for a carriage carrying four persons. In the trials organised by the *Petit Journal* last year, the prize of £200 was divided by Messrs. Panhard and Levassor and Messrs. Peugeot; and five other chief prizes were won by carriages fitted with Daimler motors. The exception was the fifth prize, won by M. Roger with a vehicle fitted with a Benz motor.

The actual amount of the prizes distributed to the winners in the Paris-Bordeaux race was 60,000 francs, divided as follows :—

	Francs.
First Prize, Peugeot Frères	31,500
Second Prize, Panhard and Levassor..	12,600
Third Prize, Peugeot Frères	6,300
Fourth Prize, Peugeot Frères........	3,150
Fifth Prize, M. Roger	3,150
Sixth Prize, Panhard and Levassor ..	3,150
Seventh Prize, Panhard and Levassor..	3,150

Besides these, two special awards of 1,500 francs each were made to another petroleum vehicle of M. Roger, and to the steam omnibus Bollée, both of these vehicles having accomplished the distance in less than 100 hours. A reserve of 3,951 francs was held for a future competition of the same kind.

In the trials in July, 1894, the second prize was awarded to Messrs. De Dion Bouton and Company for what may be called a steam horse or steam bogie. This vehicle* was exhibited at Tunbridge Wells last autumn, in the exhibition organised by Sir David Salomons, when it worked very well, forming the motor of a landau. The Comte de Dion has done a very great deal in encouraging the design of motor carriages; and the French people credit him with taking the lead towards the success which they are now able to proclaim with carriages of various kinds.

The light traction vehicle referred to was fitted at the rear with a centre pin or locking pin, and cross springs to receive the front part or steering lock of an ordinary carriage from which the two front wheels were removed. A compound six-wheeled vehicle is thus made up of the motor vehicle and carriage. The boiler is placed in front of the motor vehicle, and is of vertical form, in two main parts. It is made up of a central annular water chamber, the interior of which is the receptacle for the coke used as fuel, and is covered by a lid. This central part is surrounded by an annular chamber, to which it is connected by a large number of radiating short water and steam tubes. A diaphragm is placed in the annular chamber to cause the steam to pass by the upper radiating tubes in the annular chamber uptake, so that it may be dried. To further ensure the drying, or, rather, the superheating of the steam, it is caused to pass through a coil, which is embedded in cast-iron, and constitutes a ring, not shown, surrounding the grate. The shell tubes are at their ends let into annular grooves formed in the rings shown, through which bolts are passed to hold them together and make a steam-tight joint. The products of combustion pass upwards, amongst the radial tubes, to the annular space, and thence out at the top and down the flue. The heating surface of the boiler is 22·92 square feet; grate surface, 2·03 square feet; weight, empty, 530 lbs.; and it evaporates from 6 to 7 lbs. per lb. of coke. The compound engine used has two cylinders, 4·72 and 7·08 in diameter, with a stroke of 5·11 inches. Steam is cut off at eight-tenths of the stroke of the high-pressure cylinder, and this, at 330 revolutions per minute, is said to give 18 horse-power, which would take the motor weighing two tons, and a loaded vehicle weighing 1·113 tons, up a gradient of 1 in 12-5 at 12 miles per hour. The two cylinders were mounted on a cast-iron frame*, which carried two bearings for the crank-shaft, with a driving pinion upon it between the bearings. The pinion geared into a wheel on a short shaft carried between two bearings, the ends of the short shaft forming parts of universal joints, the other parts of these joints being formed on the jointed driving axle. The wheel on this short shaft contained within its run a differential motion. The driving wheels ran on large, short, hollow axles, or sleeves, attached to the springs, and sliding vertically through the range of the springs on a bent axle. The ends of the jointed driving axle pass the short sleeve axles (on which the wheels run), and at their outer ends carry a boss with four arms, which transmit the driving force to the felloes of the wood-driving wheels, and thus free the spokes of all driving stress. The exhaust steam passed away with the products of combustion below the motor vehicle.

As I have said, this motor vehicle was shown at Tunbridge Wells, and received a prize in 1894, but it will be seen that it is a heavy vehicle, and is provided with more power than is necessary for the required speeds or the required weights. It has no second speed gear, and so must have great power to get up hills which is unnecessary for ordinary running. The discharge of the steam is objectionable.

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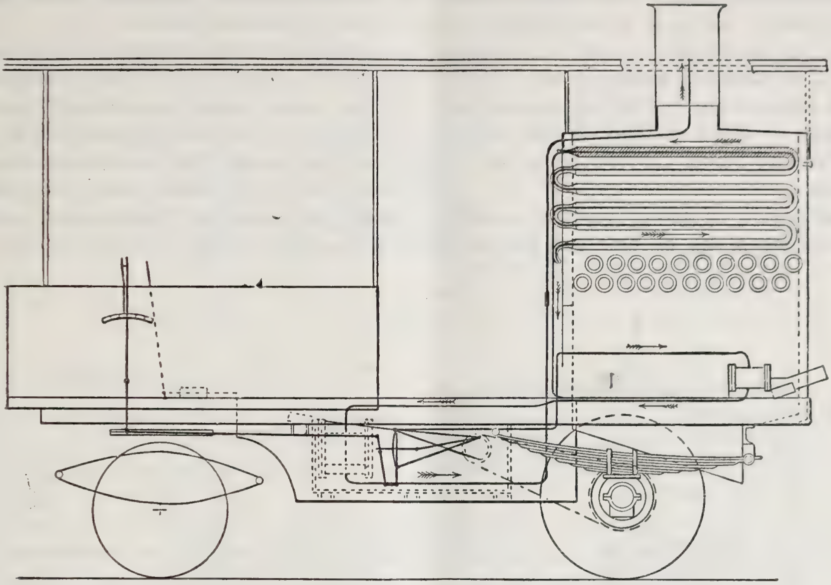
* *The Engineer*, 20th July, 1894.

* "La Locomotion automobile," Feby. 1895.

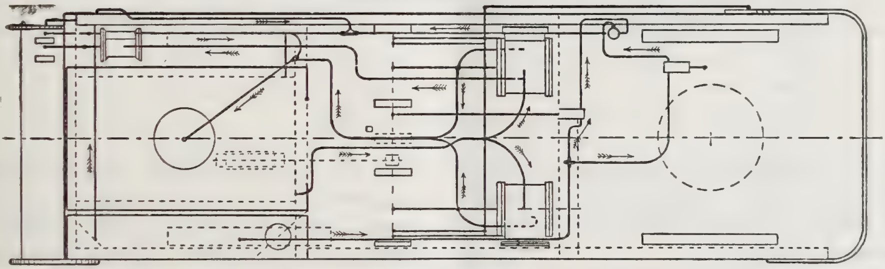
The third prize in the 1894 Paris trials was awarded to Mr. Morris Le Blant for his steam motor vehicle, having a carriage seating nine persons, and supplied with steam by a Serpollet boiler. In type it is the same as that of De Dion and Bouton. The jury considered this vehicle and its machinery specially suited for such as omnibus work. A vehicle by Mr. Le Blant is shown by Figs. 41 and 42. The boiler has no less than about 107 square feet of heating susface. The vertical section (Fig. 41) shows the position of the Serpollet boiler, and of the double cylinder engine: cylinder, 6·69 in. diameter and 7 in. stroke. It makes 185 revolutions per minute, and weighs 8·85 cwt. The boiler weighs 25·5 cwt. The total weight of this *tracteur* is nearly 4 tons, and is capable of hauling a load of 25 or 30 passengers in an omnibus or wagon, with maximum load of $5\frac{3}{4}$ tons. In the engravings (Figs. 41 and 42) A is the channel iron frame; C, C′, cylinders; G, boiler; D, differential gear, forming also the chain driving wheel; H, link motion lever; P, feed-pump; *p*, chain pinion; *m*, coupling; R, tank; R, internal geared steering-ring, with pinion, F, on vertical spindle; I, steam winch for discharging the contents of a loaded van; and J a second feed pump.

FIG. 41.



SECTIONAL ELEVATION OF LE BLANT'S TRACTEUR.

FIG. 42.



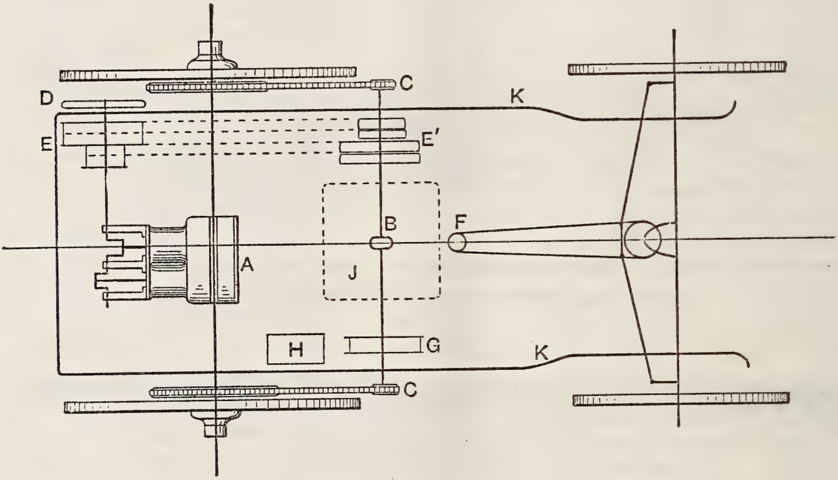
PLAN OF LE BLANT'S TRACTEUR.

Among the vehicles exhibited in Paris was a nice looking carriage with six seats, two in front, and four waggonette seats, by M. Delehaye, of Tours. A plan of the arrangement of the machinery is given in Fig. 43. M. Delehaye used a horizontal double cylinder benzoline motor, and the arrangements are generally those of the Benz Company of Mannheim. The crank-shaft is fitted with a fly-wheel, D, and pulleys, E, which, by belt, communicate motion to pulleys, E′, on a transverse shaft, B, fitted with compensating gear in the centre, and with chain pinions, C, at the ends, transmitting motion to the driving-wheels by pitch-chains. At J, is a water-tank; H, vaporiser, or carburator; and G, a brake pulley. The frame is made of steel tubes, K K, and the steering is effected as described by reference to other carriages. The engine is described as being 5 horse-power, at 550 revolutions.

A combination of motor vehicle carriage and connected brake or omnibus has been made by Mr. Le Pape.* The motor is placed immediately beneath the front seat of the traction part of the vehicle, and its crank-shaft carries a fly-wheel disc which, it is intended, shall operate a transverse shaft provided with differential gear and with a roller which, by frictional contact with the flat disc, is to give motion to the chain pinions by which the road wheels are driven.

I do not know whether this vehicle has done any work, but the disc and roller form of driving gear described, although very well worked out for its kind, is not such as would, from former experience, promise much success. The motor is provided with two cylinders, weighs 110 lbs. per horse-power, and is of 6 horse-power at 400 turns per minute. It is of M. Le Pape's design—employs benzoline and electric ignition. I mention it as containing a method of driving not used in other of the recent carriages.

Fig. 43.



Delahay's Carriage (Plan).

Between the years 1886 and 1894 a great many attempts have been made to produce a satisfactory electrically propelled vehicle for omnibus or parcels carriage purposes. An electrically propelled cab was made in 1886 by Mr. Radcliffe Ward, and its gearing comprised an arrangement for obtaining either of two speeds.

In 1888 an omnibus, built by Mr. C. H. Yeaman, M.I.E.E., manager of the Ward Company, was run about 500 miles about the streets of London, under license. An improved omnibus and a parcel van were also built by the Ward Company.

All vehicles were run with secondary batteries of the E.P.S. and Commelin-Desmajure types said to cost 3d. per omnibus mile for charging current. Fifty-six E.P.S. cells, giving 40 amperes for three hours, and weighing, with ebonite cells, 3,024 lbs., were employed, and the total weight was 3½ tons. Two 2½ horse-power Crompton motors were used, having an efficiency of 68 per cent.

The Bersey parcel van of the Street Carriage Company had 40 boxes, 52 lbs. each, 80 volts 40 amperes. Ran 30 miles on a trip with one charge, the cost of charging steam being given 10d.

It appears probable that electrically propelled vehicles of this kind may be used in towns, as although the cost of working by accumulators is greater than by any other methods, the operating advantages secured by the use of electric motors, are of much importance. The Ward Company, The Clubbe Company, and The Electric Power Company are working on these lines.

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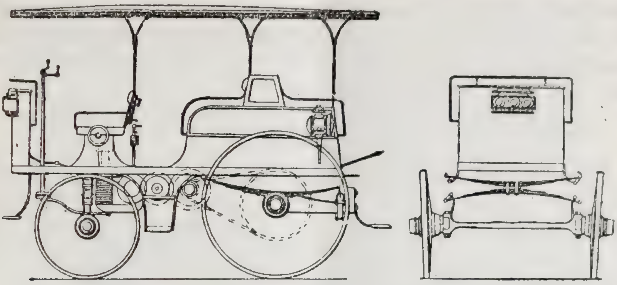
* "La Locomotion Automobile," November, 1895.

I now, again, return to French vehicles to describe an electrically propelled vehicle which was made and ran in the Paris-Bordeaux trials of the *Petit Journal*, namely, that of M. Jeanteaud. It is true that the benzoline motor propelled vehicles ran away from it, but arrangements were well made for it, and it made a good fight.

The batteries used for the Paris to Bordeaux run were of the Fulmen make, weighed 850 kilogrammes complete (between 16 cwt. and 17 cwt.), and were made up of 38 cells, contained in 12 boxes of three or four cells each. The electrodes of each cell weigh 33 lbs., and have a capacity of 300 ampere-hours under the ordinary conditions of a discharge spread over 10 hours. At the rate of discharge of 70 amperes, or 2·1 amperes per pound of plate, the capacity of the battery was still 210 ampere-hours. Unfortunately, the adoption of 10 hours as the time of discharge would place a very low limit on the rate of speed. The best speed record for electric carriages belongs at present to Mr. Jeanteaud.

FIG. 44.



JEANTAUD'S ELECTRICAL CARRIAGE.

The carriage (Fig. 44) has two cross seats, each holding two persons, and a third seat at the back, also for two persons. There is a dashboard in front carrying an electric lamp. The accumulators are placed under the hind seats. The wheels are hickory, and are respectively 39½ in. and 55 in. in diameter. The total weight of the loaded carriage is about 3 tons 3 cwt., and this is distributed so that the front wheels support 23½ cwt., and the rear wheels 39½ cwt. Each of the front wheels is independently pivoted for steering purposes on the Ackerman system already described with reference to several vehicles. A brake acting on the naves is used, and an auxiliary brake worked from either side of the front seat. The wheels are driven by two chains, from a spindle carrying the differential speed gear, giving speeds of 7 or 15 miles per hour. The change of speed was to have been done by a Bovet magnetic gear, but this not being ready in time ordinary spur gear was substituted. The motor was constructed by the Société Postal Vinay, and has an efficiency exceeding 90 per cent., and at its normal rate is intended to give 7 horse-power at 70 volts. The weight of the motor is about 4½ cwt., and it can be made to develop 14 horse-power or 15 horse-power when mounting inclines.* For the Paris-Bordeaux run it was arranged that only the steering should be done by the conductor, the driving apparatus being managed from the second seat. This includes reversing gear and switches for the accumulators, and for separately exciting the field magnets, so as to maintain the same speed down hill as on the level. This was found exceedingly useful, the motor acting as a brake, and under certain circumstances delivering back a current of 80 amperes to the accumulators. Practically, however, the amount of the current so restored was not worth taking into account, but the regulation of the speed down hill was, it is said, perfect. On the other hand, at slow speeds only portions of the accumulators were worked. A fresh set of accumulator cells, weighing 16½ cwt., was required after about 25 to 44 miles traversed, according to the gradients. For charging the accumulators a stoppage of 10 minutes was required, the connections being made automatically by springs and plates. The carriage was designed by Messrs. Jeanteaud and Brault. This carriage was run in the Paris-Bordeaux at very great expense for accumulator charging arrangements. Like all other electrical road carriages, the weight is far too great for the load carried, and, apparently, must remain so.

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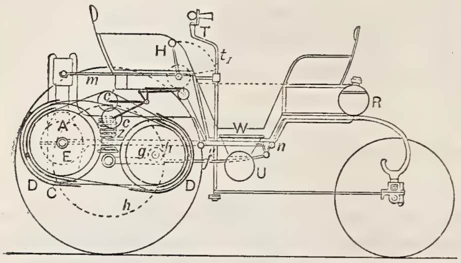
* The *Electrical Engineer*, 18th October, 1895.

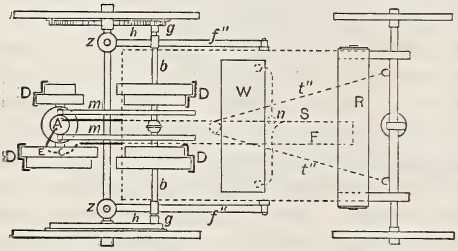
Although the several carriages by the firms who used the Daimler motor achieved so much success, the Daimler Company in London have made some modifications in the design, not only of this celebrated motor, but in the arrangement of the gear by which it transmits the motion to the driving wheels. A section showing the general arrangement, is given by Fig. 45, and a plan by Fig. 46, from which it will be seen that the power is imparted to the transverse shaft by means of belts which run over tightening pulleys, C, by the use of which either of the speeds due to the two different sizes of pulleys may be used. The water-tank which contains the cooling water, is supplemented by a second part, at W, which acts at the same time for foot-warmer in winter, and a new method of continuous water-cooling under Maybach's patent is adopted. This latter consists in directing the heated water into the annular channel of a wheel, similar to the water channel wheel used for friction brake dynamometers,* in which the warm water is whirled at the speed of the engine fly-wheel, and is taken back continuously by a tubular off-take, such as that used in milk separators. The whirling and the evaporation together effect a good deal of cooling of the jacket-water.

FIG. 45.



DAIMLER CARRIAGE (SECTION).

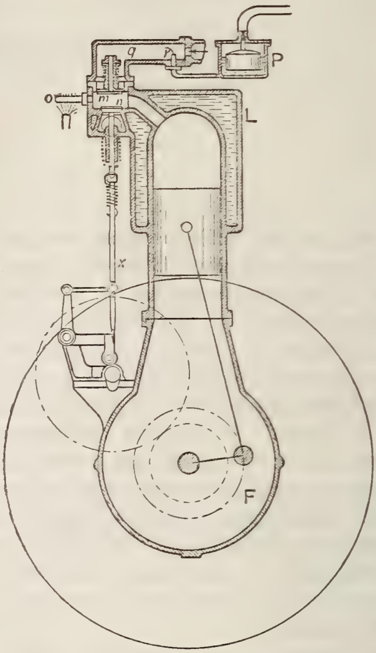
FIG. 46.



DAIMLER CARRIAGE (PLAN).

Some improvements made in the engine are shown by the next illustration. The carburetter is modified, so that no air-regulation valve is required. It will be seen that there is a slight difference between this motor and the motors that have been used hitherto. The supply of benzoline is placed in the small vessel, marked P (Fig. 47), and in it is a float, which rises and falls according to the quantity of oil in the vessel, and opens, or allows to close, a little valve that is seen above its stem. The oil is allowed to pass through a small tube from the bottom of that oil vessel, and the top of it is a very small jet nozzle, F. As the air is drawn in by the descent of the piston it enters where the arrow is shown near F, and in passing over the top of the jet, F, induces a current of oil, and at the same time breaks it up into a a very fine spray, which passes with the air into the cylinder. In this way the oil becomes converted into gas, and is easily ignited by the heated ignition tube. The governing is effected by the exhaust valve. When the engine has sufficient oil the governor holds the rod, X, up so that the exhaust valve, N (under the admission valve, M), by means of

FIG. 47.



DAIMLER MOTOR.

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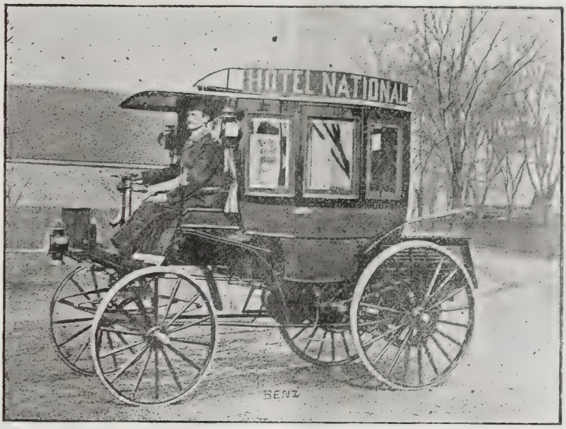
* Proc. Inst. C. E., vol. xcv., pp. 13-15, *The Engineer*, 20 Dec., 1895.

the finger at the lower end of the rod, and this valve being open no air is drawn in past F.

It perhaps will afford some proof of the confidence which is placed in the working of these carriages if I mention that the Director of Public Works at Colombo has just been authorised by the Government of Ceylon to purchase a few Daimler motor carriages for the purpose of carrying the mails from the General Post-office to the railway stations at Colombo, the daily distance to be covered by these motor mail carriages is about 20 miles, but a very large saving, it is expected, will be made by their use as compared with the use of horses.

The motor omnibus shown by Fig. 48 is one of a very large number of different types made in Mannheim by the Benz Motor Company. I have chosen this one to give you an idea of the utilitarian application to which the petroleum or benzoline motor is applied as distinguished from the pleasure vehicles already referred to. From this it is sufficiently obvious that the motor and the mechanism beyond it occupy very little space, and that it is in no way obstrusive or an inconvenience to passengers. The carriage, it will be seen, is entered as easily as any other small railway omnibus, and it is a vehicle at which no horse could take the least fright. Chain gear is used to transmit motion to the road wheels from the two sets of pulleys which are driven by means of belts, as will be seen from Fig. 46 of the De la Haye carriage, in which the Benz motor is used.

FIG. 48.



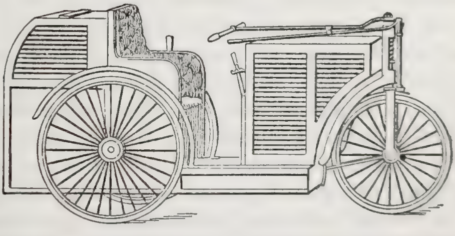
BENZ MOTOR OMNIBUS.

In the Roger carriage, already referred to, the arrangement of the gear is similar to that of the De La Haye carriage, shown by Fig. 43. A single cylinder, Bentz motor, is used, driving a crankshaft which carries two pairs of pulleys, fast and loose, for driving a countershaft with corresponding pulleys for two different speeds. At the centre of the countershaft is a Holdsworth compensating gear, and at its ends chain pinions for driving the road wheels. No arrangement is made for reversing the direction of motion, nor for these light carriages does it appear that this has been found necessary. In the larger carriages double cylinder motors are employed.

The steam carriage of M. Scotte, of Epernay, which entered the Paris Bordeaux trials, was a rather heavy vehicle, which nevertheless ran very well until one of the Field tubes of its boiler burst and brought the run to a conclusion.* Its working however was so good it was awarded the consolation prize of £20.

The little two-seat carriage, shown by Fig. 49, is one of the most recently constructed carriages now being made in two sizes by Messrs. Roots and Venables, of Westminster-

FIG. 49.



ROOTS AND VENABLES' OIL-MOTOR CARRIAGE.

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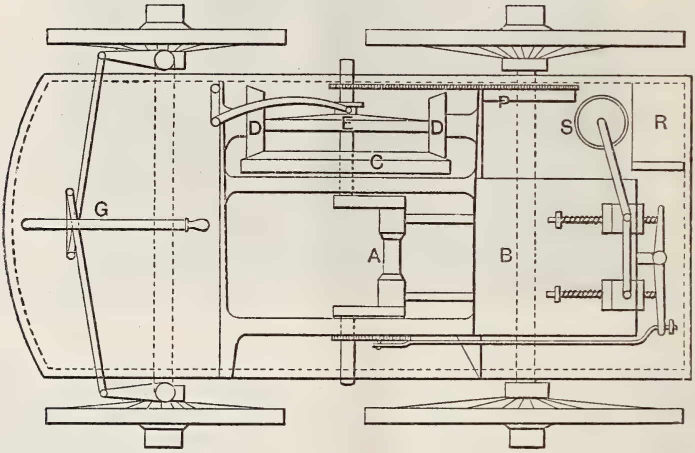
* *The Engineer*, vol. lxviii., pp. 47, 86.

bridge-road. It weighs about 8½ cwt., is fitted with a two horse-power Roots' oil (not benzoline) engine, and the larger size, to carry four persons, is fitted with a four horse-power oil engine and weighs two cwt. more. The frame is made of steel tubes which do duty as water circulating tubes supplementary to a special water cooling device in the front of the vehicle.

Several firms in England are now turning their attention to the construction of oil engines for motor carriage purposes, and many are already preparing to construct carriages and vehicles of various forms using motors of other makers. I cannot however refer to these specifically, as some of them have not yet completed their designs. The Kane Pennington motor I can only refer to as I am not yet informed as to the precise details or the system on which it works. It has recently been several times described in the engineering Press, but the description is unsatisfactory as at present given.

Fig. 50 shows in plan the arrangement of the benzoline motor carriage made by M. Tenting, and entered for the Paris-Bordeaux trials, but thrown out of the running by, it is said, an accident. It is a vehicle with seats for four, and has much the appearance of the Victoria. Like most of the French carriages, it was fitted with wood wheels, and it was driven by a double cylinder, single crank motor.* On this crank-shaft, according to published accounts, there was a fly-wheel, G, with bevilled periphery upon which two friction cones, D, ran and gave motion to a disc, E, and to a chain pinion at the back of it by which the driving axle was operated by a chain wheel, P. The arrangement thus described does not accord with the view which has been published elsewhere of the carriage taken from a photograph, but the gear is the subject of a French patent. The front wheels are carried on short axles according to one drawing, as shown, and according to another drawing they are carried on a through axle supporting ordinary locking gear.

Fig. 50.



Teuting's Carriage (Plan).

From what I have said and described, it will have been seen that the development of motors, after the subject was dropped by Hancock and others, took, with a few exceptions, the form of the heavier engine and heavy boilers with, until very recent times, comparatively low pressure. With the exception of Perkins, the high pressures which would make light boilers possible have not been used, and the new direction of development of motor has almost entirely taken the form of the internal explosive combustion engine chiefly, or the Otto cycle. All those engines of which we have heard so much in connection with the Paris trials were of this type, using benzoline; and although, as far as I know, no accident has occurred with any of the several hundreds of these vehicles now in use, an objection is felt in this country to the use of this light volatile oil.

It may be well worth considering whether the high pressure hot air engine, with internal combustion perfectly conducted, as it may be as is now known, may not yet provide the means of construction of a suitable engine with no objectionable exhaust. Stirling's hot-

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"La Locomotion Automobile," June, 1895.

air engine* may, to some extent, form an indication of the lines on which some theoretical and practical considerations, with this object, might be based, internal combustion of oil by a burner under pressure being used instead of the externally heated cylinders of Stirling's engine. So much is known now of the combustion of liquid hydrocarbons under different pressures and temperatures that, aided by some of the devices for ignition which have been used in oil and gas engines, it would seem that the time has arrived for devoting some attention to development in a direction which seems to have been neglected.

Now, the time has so quickly passed, that I must leave other illustrations of what has been accomplished, and refer for a few minutes to questions that will be of more interest, perhaps, to those who are considering the motor carriage of the future. The first thing that has to be considered is, who will want, and what are the purposes to which, motor carriages are most likely to be applied. We have to consider this, because, already people are talking of making carriages—or vehicles, I would rather say—that fulfil no particular requirements, and which seem to have no particular recommendations, as considered from the point of view of any of those who want them for pleasure purposes, those who want them for business purposes, or those who want them for heavier work. The next point we have to consider is who can use the carriages? when they are made, that is to say, what sort of man or attendant will be necessary to keep in order or to work either of the forms of carriages that have to be made. Must we have a trained mechanic, or must we have an intelligent engine - driver, or will it be sufficient to have an ordinary, intelligent handy man, such as many gardeners, who can, and do at the present time, drive gas-engines to run dynamos in many country houses? Or can the carriages be fitted with motors? and there is no doubt some of the benzoline motors are made, so that they give very little trouble to men who, with a little mechanical sympathy, can attend to the vehicles themselves. If we make vehicles like a good many of those that have been constructed since the time of Hancock, which require a driver, and separately a stoker, we shall be making something that will be—except for omnibusses and the heavier work—inferior to those which are, or will be, made by our neighbours, more especially for the small vehicles. When we have to supply a vehicle for those who will use them for business purposes, vehicles of the heavier order, this objection does not obtain, or does not obtain to the same extent; but we have to remember that if business is to be done on any scale with these vehicles for general users, these users must be able to run them without difficulty. No skilled, or very little skilled attention must be necessary, otherwise we shall no more get the English people to use them than we would get them to use tricycles or bicycles if mechanical skill were required. Another point that I would mention is the question of speed. Most of those of the early days, whose carriages I have described, lost a great deal by attempting too much speed. For road carriages it is a question whether high speed is necessary at all. Very moderate speed will, in the opinion of most people whose opinion is, I think, worthy of consideration, be sufficient. It is useless to make vehicles provided with the capacity for very high speeds; vehicles which are capable of attaining those speeds will, after all, not be permitted to be used, firstly, because they will be dangerous, and, secondly, because people will not buy vehicles which have powerful engines whose power is seldom, if ever, wanted. The vehicles which are required will, as a rule, have to run at slow speeds or at moderate speeds, and the means of running at high speeds can only be obtained with heavy motors and gear. With regard to the changes of speed, that is to say, variable speeds for the different purposes of level roads and hills, and starting, and so on, I think it may be seen by careful consideration of what has been done, and what is wanted, that the motor which will give the moderately high speed of (say) 10 to, at the most, 12 miles an hour, and only provided with a simple low speed gear such as will enable them to start easily or to get up a hill as horses do, at a very moderate speed, but which will, at the same time, be the means of using an engine of very small power, will be that which will meet most requirements. In order to obtain a number of speeds, or a great variety of speed, we must have either complicated gear, or we must have a great reserve of power. Great reserve of power means greater weight than is necessary for that which, in 90 cases out of 100, purchasers of these vehicles will require. I know that the speeds that have been obtained by several of the English engineers to whom I have referred are easily obtained, but you will find that it was only by means of very considerable weights; weights that were absolutely unnecessary for anything like the ordinary uses to which these vehicles will be put, and even then those speeds were only obtained by engines and boilers which formed about 75 per cent. of weight of the vehicle and the load they could carry. We see the oil motor carriages and the benzoline motor carriages have already run very far away from that sort of thing, and it remains for us to show that we can make vehicles which will enable us to arrive at the speeds that are useful, and at the same time at a vehicle which is light, simple, and not too costly. The French and the German motor carriage makers have already done well, but there are not I believe more than a few whose carriages can, for English requirements, be looked upon as more than in the advanced experimental stage. We shall require carriages which weigh no more than theirs, but which are stronger in all the essential gearing and wearing parts, and which are much quieter and in no way a nuisance.

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* Bourne, "Steam, Air, and Gas Engines."

The next point, and I will only occupy a minute or two more, is the question which has no doubt been occupying the minds of a great many, viz., is the motor to be steam or electricity or petroleum engines, or what form of motor is it to be for these carriages of the present and future. To one point on this subject I have already referred. There is, most persons think, a good deal of room for the steam motor, although the oil motor has been running away with most of the prizes of late. It will not do, however, to think that the steam motor carriage can be made whose duty is chiefly to carry an engine and boiler.

Most of the boilers that have been used by those who have worked in this direction hitherto, or at all events since the days of Hancock, Church, and others, have been too heavy. It will be necessary to use boilers of the race-horse type, probably boilers of the instantaneous generation type, boilers on the principle of that to which I have referred of M. Sepollet, boilers that make it unnecessary for the driver to be very much troubled as to where the water stands, or when called upon to stop in consequence of an accident on the road in front of him, or of a block in the traffic in the streets. He must be independent of that, otherwise the steam boiler is out of it for that sort of work. Even if boilers to carry any given quantity of water are used, then that which has already been shown to be possible, viz., self feeding, self-regulating arrangements must be used, but they must be of a simple order. Then, these things being secured, we have to admit that the steam-engine has some advantages over other motors, inasmuch as it may be stopped and started at any instant, to give any power from a few foot-pounds up to its full power, and is, in fact what railway men call more flexible than any other form of motor; and it is not impossible that a steam-engine in the form of a rotary engine, that is to say, a steam turbine, may be used, which would run practically without vibration. The only difficulty—perhaps the one difficulty, in this sense—is the form of gear that shall reduce the very high speed of the steam turbine down to the speed of the road wheels. That overcome, we have to-day, a steam motor, which, for such powers as we require for these purposes, is as economical as the high-speed reciprocating engine. The gear I have already mentioned, and I may say again that, if it is to be used at all in these things, it must be much more simple than any that has been used at present.

The last point to which I would refer is the fact that wood wheels have been preferred in the many carriages lately built, and have been very successful, and there seems little doubt that indiarubber tyres, perfect as they now are, ought to enable the engineers and carriage-builders to achieve success far more complete than that of our forefathers, great as it was, fifty years ago. We may use for many vehicles with perfect success, and with much greater cheapness than many people are aware, pneumatic tyres of several forms. It is hardly necessary to mention the names of those who make them, but everybody knows the Dunlop, and the Pneumatic Tyre Company, and the North British Rubber Company, who make them of forms now that overcome the difficulties I mentioned last week. I referred to Thompson's tyres, which were soft india-rubber throughout their whole thickness, and which, under any speed, left the wheels upon which they were running, and preceded them in front by several inches, and in that way did work upon themselves, which gradually meant deterioration. These tyres are made now with the soft form of india-rubber on the exterior, and with the harder vulcanised india-rubber within; so that the part that fits upon the wheels is hard and non-extensible, and has no tendency to break away from the rim of the driving wheels. The various points that I have been able to put before you have only lightly been touched upon, though I hope I may have directed attention to those that are of some importance, in what everybody hopes will be a great industry. We have seen how very rapidly the cycle manufacturers, by the aid of machinery which will reproduce cheaply very nicely constructed details, have shown all engineers how to use ball bearings with very great success, though we used to think little of them a few years ago; have shown us how to make light frames for light vehicles with perfect success, and they have shown us how an industry which employs hundreds of thousands of people may be created in a very few years. I think what they have done is an encouragement to us to persevere in the design of a conveyance which shall be all that the public will require, and not merely that which the engineers would like to design. It will encourage us to insist upon the removal of those legal restrictions which at the present time are alleged at all events to be the chief cause of our being as manufacturers second to those of France and Germany, instead of being first, as we should have been if we had properly followed up the work of the English pioneers of 60 years ago.

Miscellaneous.

LOAN EXHIBITION OF ENGLISH FURNITURE AND FIGURED SILKS.

The Lords of the Committee of Council on Education have directed the formation, at the Bethnal-green Museum, of a loan collection of examples of English furniture and figured silks of the 17th and 18th centuries, which will be opened in April, 1896, in the galleries recently occupied by the national portraits, which are now removed to Trafalgar-square. Recent changes of fashion have caused a demand for 18th century patterns in figured silks, the manufacture of which formerly gave employment to 60,000 weavers in the East of London, and the designs of the early days of George III. are now being revived or adapted. Possessors of dresses and costumes made of these silks will be invited to lend them for exhibition, and, as 18th century trade pattern-books—which attach to cut examples of the silks the names of weavers and merchants—will be included, comparisons between the designs in these samples and the patterns in the old costumes will probably lead to greater accuracy in dating the English figured silks already in the possession of the Museum. The loan collection will remain open for six months; and, in addition, the Bethnal-green Museum will be enriched by the generous loan by Sir Wollaston Franks of his collection of European porcelain, and by the Chantry Bequest collection of pictures lent by the Royal Academy.

Correspondence.

CYCLE RAILWAYS.

In a paper read at the Cyclists' Congress at Northampton, and afterwards printed at full in *Invention*, I suggested the construction of cycle railways for postal communication, and for the conveyance of small parcels. The cycles were to be quadracycles, with flanged wheels, and running upon rails—very light rails—and bearing light carriages propelled by pedals, though, at the same time, I contemplated a period when mechanical motors adapted to such vehicles would come into use. The speed that could be obtained on such cycle railways has scarcely been considered, more especially if petroleum and other motors could be applied to them. If mechanical motors can be furnished to common road bicycles and tricycles, how much more effectively could they be applied to quadracycles upon rails? Yet no thought seems to have been taken, in the discussion on cycle motors at the Society of Arts, of the possibility of a very important new departure being made in light railways, on which "express" speed might be obtained in certain localities and for special purposes.

W. CAVE THOMAS.

Obituary.

SIR JULIAN GOLDSMID.—The Right Hon. Sir Julian Goldsmid, Bart., M.P., who died on Tuesday, 7th inst., was elected a member of the Society of Arts in 1879. Sir Julian was born in 1838, and succeeded his uncle as third baronet in 1878. He was M.P. for Honiton 1866-68, for Rochester 1870-80, and for South Pancras from 1885; and held the office of Deputy-Chairman of Committees in the House of Commons.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 15.—"The Making of a Great University for London." By PROF. SILVANUS P. THOMPSON, D.Sc., F.R.S. THE LORD REAY, G.C.S.I., G.C.I.E., will preside.

JANUARY 22.—"Supply of Sea-water to London." By FRANK W. GRIERSON.

JANUARY 29.—"Standards of Light." By W. J. DIBDIN, F.C.S. CAPTAIN W. DE W. ABNEY, C.B., F.R.S., will preside.

Indian Section.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock :—

January 16, at 4.30.—"The Shan Hills: their Peoples and Products." By Colonel R. G. Woodthorpe, C.B., R.E., Indian Survey Department. The Right Hon. George N. Curzon, M.P., will preside.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 14.—"The Poster, and its Artistic Possibilities." By Gleeson White. Ernest Hart, D.C.L., will preside.

Foreign and Colonial Section.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

January 28.—"Stamboul: Old and New." By Richard Davey.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

Dr. J. A. Fleming, F.R.S., "Alternate Current Transformers." Four Lectures. Jan. 27; Feb. 3, 10.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 13...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. James Barnet, "A Moveable Level or Inclined Floor." 2. Dr. Stevenson Macadam, "Destructors for Consuming Town Refuse—their Requirements, Defects, and Modes of Improvement." 3. Mr. G. W. Herdman, "A Hinged Form of Astygmatic Eye-Glasses."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Lyonel Clarke, "Optics and Lenses."

British Architects, 9 Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Jesse Herbert, "China and the Chinese."

Tuesday, Jan. 14 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section) Mr. Gleeson White, "The Poster and its Artistic Possibilities."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Coverings of Plants and Animals: its Structure and Functions." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Hon. R. C. Parsons, "The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water Supply."

Photographic, 12, Hanover-square, W.C., 8 p.m. Mr. H. L. Aldis, "Astigmatism and a New Stigmatic Portrait Lens."

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m. Annual Meeting.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Rev. W. J. Holland, "A Preliminary Revision and Synonymic Catalogue of the *Hesperiidæ* of Africa and the Adjacent Islands, with descriptions of some apparently new Species." 2. Dr. Arthur G. Butler, "A Collection of Butterflies obtained by Mr. R. Crawshay in Nyasaland between the months of January and April, 1895." 3. Dr. G. Lindsay Johnson, "A Newly-discovered Modification of the Iris in the Eyes of certain of the Ungulata adapted for assisting Vision."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. William Austin Horn, "The Scientific Exploration of Central Australia."

Wednesday, Jan. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Silvanus P. Thompson, "The Making of a Great University for London."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. Annual Meeting. Presidential Address by Mr. R. Inwards, "Meteorological Observatories."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual Meeting. Presidential Address by Mr. A. D. Michael.

Entomological, 11, Chandos-street, W., 8 p.m. 1. Annual Meeting. 2. Address by the President, Professor Meldola, "The Speculative Method in Entomology."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. J. S. Sunderland, "The Engraving and Toning of Half-Tone Blocks."

Civil and Mechanical Engineers, 45, Charing-cross, S.W., 7 p.m. Mr. F. R. Simms, "Mechanical Locomotion on Common Roads."

Thursday, Jan. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Colonel R. G. Woodthorpe, "The Shan Hills: their Peoples and Products."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Professor T. Rupert Jones and Mr. F. Chapman, "The Fistulose Polymorphinæ and the Ramulinæ."

Chemical, Burlington-house, W., 8 p.m. Prof. Vivian B. Lewes, "The Acetylene Theory of the Luminosity of Hydrocarbon Flames."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Fleming, "Experiment with Incandescent Flames."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Philip H. Wickstead, "Dante." (Lecture I.)

Electrical Engineers, 25, Great George street, S.W., 8 p.m. Dr. John Hopkinson, Presentation of Premiums. Inaugural Address by the President.

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Sir W. Martin Conway, "Views in the Himalayas, with Notes on the Photographic Needs of Mountain Explorers."

Friday, Jan. 17...Royal Institution, Albemarle-street, W., 8 p.m. (Weekly Meeting, 9 p.m.) Lord Rayleigh, "More about Argon."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. W. O. Leitch, "Iron Tunnels."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Jan. 18...Royal Institution, Albermarle-street, W., 3 p.m. Dr. A. Donaldson Smith, "To the North of Lake Rudolf and among the Gallas."

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FRIDAY, JANUARY 17, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1896.

The prize is offered to the student who obtains the highest awards in the following subjects:—

(*a.*) A finished drawing of imperial size from the nude living model.

(*b.*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c.*) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d.*) Drawing from the life done at the Examination on May 2, 1896.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892 or in 1893 cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art in April, 1896. Each competing drawing must be marked, "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

EXAMINATIONS, 1896.

In accordance with the notice given in the Examination Programme, that additional subjects might be added to the next examinations, the Council have now arranged for the holding of examinations in "Economics" and in "Précis-writing." For the former subject, the examiner will be Mr. W. A. S.

Hewins; for the latter, Mr. S. C. Paul. Should a sufficient number of candidates present themselves, examinations will be held in Economics on Thursday, March 26th, from 7 to 10 p.m.; in Précis-writing, on Monday, March 23rd, from 7 to 10 p.m. A syllabus for each subject will be found on page 144, January 3, 1896.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

INDIAN SECTION.

Thursday, January 16: The Right Hon. GEORGE N. CURZON, M.P., in the chair.

The paper read was "The Shan Hills: their Peoples and Products." By Colonel R. G. Woodthorpe, C.B., R.E., Indian Survey Department.

The paper was illustrated by lantern slides taken from Colonel Woodthorpe's drawings, and with drawings, costumes, &c., shown on the walls.

The paper and discussion will be published in the next number of the *Journal*.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Technical School, Bury.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, January 14; ERNEST HART, D.C.L., in the chair.

The paper read was—

THE POSTER AND ITS ARTISTIC POSSIBILITIES.

By GLEESON WHITE.

Until lately, the pictorial placard appealed only to the advertiser; with a very few exceptions, which only served to emphasise the worthlessness of the others, the poster was a thing of no account. Now it has become a craze. Artists see in it a source of fame and income; critics find it a pleasing subject to exploits; collectors forsake the blithe postage stamp, and the modern book-plate, to hoard acres of coloured lithographs. To-night, therefore, we might consider it from several points. From the point of the historian—from the advertiser's standpoint—or from that of the collector. But it seems more in harmony with the Society of Arts to discuss it chiefly in its artistic aspect. Although its anecdote, especially if one went back to the posters of the French Revolution, or those of the Frost Fair on the Thames, would be far more interesting.

Yet it is hardly essential to attempt to trace the origin of the poster, even if one did it as lightly and pleasantly as Mr. Charles Hiate has done in his "Picture Posters," the first English book on the subject. But not the first volume devoted to it; for it may surprise many people to learn that a whole literature of the poster is growing up; not merely confined to books, but having its own periodicals devoted solely to the cult.

Not merely are there collectors but vendors. So long ago as 1891 a French trader, Mons. Sagat, published a catalogue wherein over 2,000 examples were described and priced at sums which now appear marvellously low. Then a few francs brought the rarest, now a few sovereigns would hardly secure them. Books have appeared, some as sumptuous as Maindrion's new volume, wherein Jules Chéret is duly catalogued in 882 entries, and sixty colour plates, with a huge reinforcement of process blocks fill up a stately quarto, or Mr. Hiate's "Picture Posters," with its 150 reproductions, others trifling pamphlets, but all enthusiastic. As, for instance, in Mr. Clarke's admirable preface to the catalogue of the Aquarium show, in Mr. Bella's article in *La Plume*, Mr. Wedmore's essay in *The Art Journal*, Mr. Spiellman's papers in *Scribner's Magazine*, and many others of Transatlantic and French origin. Nor must we overlook a show of pictorial advertisements gathered together by Mr. John Leighton to illustrate his lecture at the Conduit-street Galleries, in 1893.

But it would serve no definite purpose to discuss exhaustively the manners and styles of the artists who have essayed it. To do so would occupy all the time at my disposal. Besides to attempt to convey descriptions in words—of posters not on these walls—were mere wasted effort, and to describe those in sight would be still more foolish. Nor is it even needful to attempt to trace the evolution of the modern poster, except so far as concerns a few typical early examples which (as originals were not obtainable) I have to show you as lantern slides later on.

My object to-night is not so much the poster as it was, as to discuss posters as they are and as they might be, and to this end must call attention to a few typical examples.

At first sight nothing could seem more superfluous than to call your attention to any placard. For the very object of its existence is surely to force itself on your notice.

Indeed a poster that required a guide to point it out, would thereby confess its inefficiency.· It reminds one of the old story of the indigent gentlewoman reduced to selling muffins for her livelihood, who gave her cry as softly as she could, and added to herself in a whisper, "I hope nobody will hear me."

But the object of a poster should be not merely to attract attention but to detain it. A good poster once seen, it is impossible to forget, and if it comes back to memory easily the very fact proves that it had at least one quality required, that of individuality. But it is not sufficient to attract attention only, it must attract it attractively. Should the design repel you, surely its special pleading will be wasted. For if by some unexplained law a specious request that you shall buy somebody's cigarettes—or sewing-machines—is calculated to render you obedient to do its bidding, it should not exasperate you into becoming an enemy by the character of its design. If, indeed, a poster ever tempts you to buy an unknown article. Its use is more probably a constant reminder to remain true to the soap, or whatever it might be that you have already tested, and not to forget old and tried friends.

To me, I must confess, that the whole question of indiscriminate advertising seems a curious survival of blind faith in commercial men marked otherwise by extreme shrewdness. Yet all the same, the faithful prove, by statistics of profit and loss, that advertising does tell directly, and that if it be suspended for a while, their balance-sheets betray the corresponding loss clearly enough.

Yet it seems inconceivable to think that any one chooses his soap, for instance, because a poster bids him. Speaking personally, I know I use a particular kind because I like it; and, so far as I am aware, it is not advertised at all. I tried it by chance, and like Mr. Furniss's hero, "have since used no other." Despite the blandishments of "Bubbles," the charms of the young lady who washed herself ashore, and the dozens upon dozens of other placards, I prefer the sort I happen to like best. Nor, do I take my morning paper, because it has the largest circulation—of course it has, because every morning paper claims that as its initial fact—although it is not clear why the largest circulation is supposed to appeal irresistibly to you. Is it so with other people? In matters of evidence, one's own experience always appeals most forcibly, and possibly one exaggerates the effect.

It is rather curious to see how few newspapers, who may be supposed to be past masters of the art of advertising, have (rarely in England, at least) resorted to the picture poster. A few weeklies—*The People*, *Lloyds*—have done so. The *Star* began with a classical figure; and, I think the *Sun*, with a fine disregard of omens, had a picture of Phœbus driving his ill-fated chariot upon its early placards; but, so far, the big dailies here prefer solid, clear type, with solid, and not always modest, statements set out in plain and alliterative English.

In America, at all events, the picture poster is already fully impressed into the service of the press; and dozens of gaudily attired females, in garments which would make a dahlia or a nasturtium die of despair, announce the supreme merits of the various papers and magazines, with a fresh design for each month. These, from their size, may be more accurately classed as window bills; but they are posters essentially, notwithstanding their modest dimensions.

What a poster should *not* be I think we can easily find out from a few typical and horrid examples. Only a few weeks ago, in a provincial city, I observed a big hoarding placarded with huge coloured bills, hardly one of which I had ever noticed in London. From a careful study of these, I realised the progress we have already made here, for their average was singularly bad. So one may gather hope and believe that those responsible for such matters are awakening, and that (as it should be) London is the first in the movement. But Paris has been years before alive to the wisdom of making posters works of art in their own way, and America, recently captivated by the same idea, is carrying it rapidly into practice; for the American manufacturer has one very important bit of knowledge—he knows the limits of his own ignorance. Here too often the manufacturer engaged in business that leaves him no time to keep in touch with the progress of popular taste; still, believes he is able to judge it. In America, a man first confesses he is not sure that he knows best, and then engages an expert to supply him with the best thing, not counting cost, or, at least, not unduly sacrificing effect for parsimony.

I wish I had that hoarding I spoke of for a background to-night. As an object lesson of chromatic villany, of flat, unmitigated ugliness, the effect of such posters as I have around me would be more striking by contrast. You need a horrid example or two to throw better work into due relief.

And here may be a good place to explain that there is no quality of "high-art" in a poster or a painting, which is not also obedient to the laws of common sense and good taste. No matter if we left art out of the question, and only spoke of practical utility and good taste, we could justify the better class of posters, and condemn the worse on these grounds alone.

In analysing these to discover their most prominent faults, I found that (putting good drawing and good colour out of the question) there were many other vital defects, as fatal from the advertiser's point of view, as from the artist's.

First, poverty of idea was very striking. For instance, on a poster to announce somebody's pianos, you saw a young lady seated at a pianoforte, with a gentleman standing by her side. I use the conventional terms to describe the figures, but a less gentlemanly gentleman, and a less lady-like lady, it would be hard to discover even in a penny dreadful. The colours were not simply vile as colour, but most ineffectively employed. For the simplest colour, as in a national flag, for instance, can be so arranged that it tells as a striking decorative pattern. Here the colours were distributed anyhow over the black lithographic surface. Whether there were three or a dozen, you could not discover, except by careful inspection. A child painting a print with a penny box of water-colours would have made as good a coloured picture.

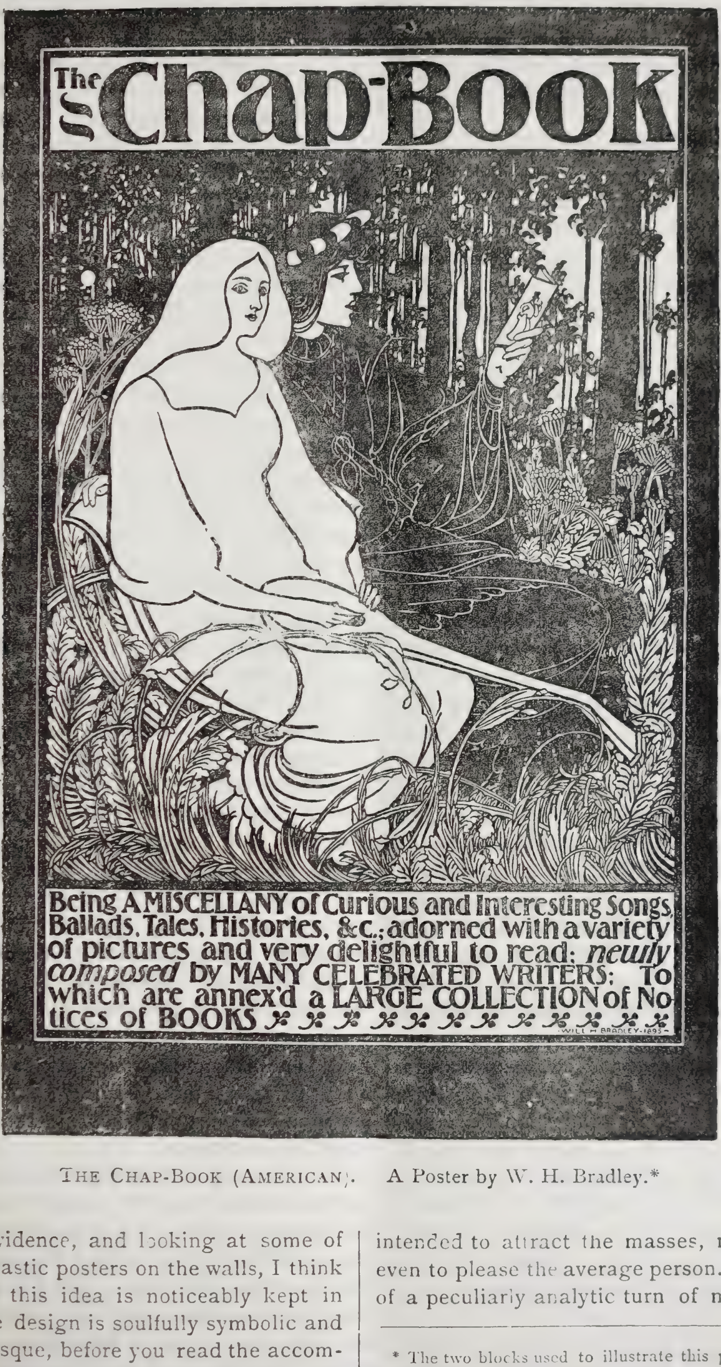
But so far you may say these objections are merely artistic. But the commercial shortcomings were equally noticeable. The lettering was badly placed and illegible from a short distance, owing to meaningless so called ornamental letters being employed. This is surely a fatal defect.

The poster in question was meant to advertise pianos—only pianos nothing else. Yet equally prominent in the one I am noticing were—a man in evening dress, and a woman in a smart frock, a whatnot, a mirror, an overmantel, a plant in a pot, and a folding screen. It might have been meant to proclaim the merits of cheap furniture, of somebody's music, of clothes, or of cough drops. For all you could discover until you read the legend, it would have done equally well for either purpose.

Now compare this style of poster with a design by the Beggarstaff Bros., which I had hoped to show you to-night (it was hung at the Exhibition at the Royal Aquarium), also intended for pianos. In the foreground, a large black grand piano was full in evidence, a player was seated at it; behind were row after row of the audience filling the orchestra seats, as they do fill them at pianoforte recitals at St. James's-hall, and elsewhere. At a glance you could see that the piano was the dominant subject—the rest was mere decoration, but decoration of the right sort, that emphasised the theme. For obviously it was a great pianist playing, and the man in the street could argue therefrom that the piano must be a good one to be used at a big concert.

You may say that such a scene could not appeal to would-be purchasers of a simple cottage piano—to people who quite possibly had never attended a piano recital, and may never have seen a big concert grand piano in their lives. True! *but those who buy grand pianos are familiar with such things*, and therefore this appealed straight to its audience. Had the designer been commissioned to advertise cheap cottage pianos you may be sure you need never have been in doubt whether it was the merits of furniture, clothes, or cough-drops he intended to proclaim.

For the poster must first attract the attention of the possible buyers of the wares it advertises, but not necessarily with the simple savage form of hieroglyphics, pictures of the facts—it may merely act as a liveried attendant whose duty—like the Harper's beef-eater—is to call to you to stop and read his proclamation. Suppose one wished to advertise a costly brand of champagne then it might be quite in keeping to produce a design which would not please a costermonger, yet if you desired to advertise a thing used by everybody, high, low, rich, and poor, you could not be too simple and too clear in keeping the purpose strictly in evidence, and looking at some of the ultra-fantastic posters on the walls, I think you will find this idea is noticeably kept in mind. If the design is soulfully symbolic and weirdly grotesque, before you read the accompanying legend you may be sure it is not intended to attract the masses, nor, perhaps, even to please the average person. A barrister, of a peculiarly analytic turn of mind, discus-


The Chap-Book
Being A MISCELLANY of Curious and Interesting Songs, Ballads, Tales, Histories, &c.; adorned with a variety of pictures and very delightful to read; *newly composed* by MANY CELEBRATED WRITERS; To which are annex'd a LARGE COLLECTION of Notices of BOOKS
WILL H BRADLEY 1895

THE CHAP-BOOK (AMERICAN). A Poster by W. H. Bradley.*

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* The two blocks used to illustrate this paper are kindly lent by Messrs. George Bell and Sons

ing some of these with me, gave his opinion in their favour. He said it is good to puzzle people ; if they think over the puzzle and find it out their trouble and cleverness helps to fix the fact in their memory. If they fail to elucidate these dark sayings they have the serene consciousness that the designer must have been a fool not to make his meaning clear, and this fact they also store up as a grudge against him—perhaps; but the poster has done its duty in impressing itself on their memory.

Another type of poster on the hoarding in question, and common enough everywhere, as we all know, has a small waisted figure of proportions never seen out of a fashion plate. The dress so far as a mere man may dare to criticise it, is appallingly hideous, and calculated to repel the average woman But the chief offence of the particular design I have in mind, is that the name of the owner, who had spent so much money in advertising his place of business, is absolutely illegible. The grotesque letters which presumbly announced it keep their dead secret. To this day I do not know if the initial is a C or a G, or some other letter. The whole name is a hieroglyphic absolutely indecipherable. Now if art criticism stands appalled by the inanities of fashion, and has to suffer these terrible dolls, common sense may revolt against an illegible inscription. In this matter the verdict of the man in the street would agree with that of the trained designer. If you could only make him see that the figure was as far from common sense as the wording, then indeed the worst poster would be an educational blessing in disguise.

Yet this puerile picture, no doubt, satisfied the æsthetic taste of several people ; we may presume its designer was content with it, and that its purchaser was willing to take the responsibility of exhibiting it. If you go back to the older fashion plates, despite the absurd prettiness of the heroines, there was some faint likeness to humanity. Now, no grotesque perversion of the Beardsley ideal is farther from the canons of proper proportion than the figures on the posters of many drapers of repute. Probably, no other class of advertisement is so utterly contemptible : the sensational drama-poster is an academic masterpiece in comparison ; the worst coloured photograph is preferable; for these ridiculous puppets are impossible in every respect. Yet they provide a fair number of the placards on any hoarding to day, and, I am told, are paid for at prices high enough to secure genuinely artistic work; they are neither realistic nor decorative, neither good picture nor good pattern. In the minds of a great many people, who ought to know better, decoration and pictures are mixed; they think that the best way in fact—some of them appear to think that the only way—to decorate an object is by sticking a picture on it.

Now, a poster may be, more or less, a picture; but even here the principles of decoration may be reasonably observed. The average person thinks the more a poster is a picture the better. Yet if you compare the effect of a really marvellous rendering of Sir John Millais' "Bubbles"—marvellous, considering the size and the vast number of impressions printed—and put it next to Steinlen's "Child with Cats," now being used to advertise Nestlé's milk, you will find that from a distance where "Bubbles" would be ineffective, provided you had not previously seen it, and so brought memory to help vision, the Steinlen design would tell out clearly. Then contrast the way each tells its story. The Millais picture was not designed for advertising purposes, therefore one may criticise it as a poster with no disrespect to the great artist who painted the really admirable original. It is true bubbles are the result of soap and water; but the child drinking milk with the cats eagerly awaiting a share, is far closer to the idea—which is milk—than is the boy watching a bubble—to soap. These two examples are each masterpieces of their class, and hence may fairly be set against each other. The one is a picture forced to the purposes of a poster, the other a poster pure and simple—designed for a purpose—fulfilling it admirably—good enough to arouse the warmest appreciation from a painter, simple enough for a gutter urchin who could not read to understand its anecdote. Yet, perhaps, to criticise them on the same lines as I praised the piano poster, would reveal a discrepancy. Milk is an article which appeals to all classes. Soap attracts a more limited number, so possibly the two must not be considered as exactly equal in importance.

The artistic defects of the ordinary poster are even more numerous. It is nearly always crude in colour, and, often enough, poorly drawn. It is obvious that one does not look for quietly sumptuous harmonies of colour ; but for striking and bold schemes that insist upon forcing themselves on your notice. The repose of a great portrait by Velasquez would be a defect in a poster. On the other hand, we find in dozens of Japanese colour prints, gay and arresting schemes, which depend not only on the combination of brilliant tints, but on the simplicity of their large masses. The absence of background in many of these, or a merely conventional treatment of landscape or interior, as the case may be, also reveals patently that the colour print of Toyokuni or Kuni-sada is a excellent model upon which to base the scheme of a poster.

Simplicity of form, carried to its extreme limit in some of the very clever designs by the two artists who sign themselves the Brothers Beggarstaff is the ideal of one type of the peculiarly English poster. Yet as Jules Chéret, the father of the modern poster proves, in nearly nine hundred instances, this mosaic of flat colours is not essential. When you see a batch of fine Chéret's in sunshine on the walls or kiosques of Paris you are tempted to think them the best of all possible posters for the best of all possible cities. But when in the golden haze of an autumn afternoon you catch sight of a Grieffenhagen "Pall-mall Budget," a Dudley Hardy "To-day," or "Phit-Eesi Boots," or a big red beefeater proclaiming the quality of "Harper's Magazine," you recant. and think the English poster better than the best, for the city which is—to one who loves it—far more beautiful than Paris or New York. For the poster must agree with its enviroment, and schemes which would be sparkling and jewel-like in a clearer atmosphere need to be replaced by bolder attempts in a mist-laden town.

For, despite many excellent people who condemn—as we all do—the inartistic advertisement that disfigures our landscapes, it would not add to the gaiety of cities were the poster prohibited. I remember a wet day on the Liverpool quays, where miles of drab-coloured houses and roads looked grimy until you came across a huge hoarding that sent great splashes of colour down the pavement half a mile towards you, making almost the effect of a mimic sunset.

For a poster to tell at a distance through the atmosphere we call abnormal (because a dozen days in the year we do not have it with us) it must be very simple, and eschew graduated washes of colour that owe their beauty to subtle combination of the tiny specks whereby broken colour is achieved in lithography. Besides, the more modern poster is economic in its use of colours, and frequently obtains better effects with two or four pigments than the old-fashioned design did with three times the number.

But simple colour need not be allied with grotesque or archaic forms. A distinctly happy idea, such as the scene from Mr. Penley's popular play—with the legend, "Charley's Aunt still running"—would have been not less but more satisfactory, had its artist abjured the picture and treated the incident more decoratively, as the designer of the new poster for "Mrs. Ponderbury's Past" has treated an actual scene in the play. On the other hand, the colour of the first posters of "The New Boy"—the Reckitts' blue suit of Mr. Weedon Grossmith's portrait, which was apparently enlarged from a photograph—although it had no background, was undecorative; and when seen in a row, still more depressing in its sordid realism: for the detail which accords well enough with a cabinet photograph is ludicrous upon a poster. This possibility of the single design being so arranged that it is still more effective in a group was most strikingly evident in the frieze of Dudley Hardy's "Gaiety Girl" at the Prince of Wales' Theatre.

There are others we must be silent about, because any expression of opinion would be libellous. They are, to a trained eye, what an out-of-tune piano organ is to the trained ear. If even an entirely admirable production, considered on its own merits—like Millais's "Bubbles"—becomes trying when seen over and over again, how much more are some far more frequent horrors?

To avoid suspicion of prejudice, it may be as well to quote an American opinion of English posters printed in 1892. It is Mr. Brander Matthews who is criticising us, and we know that things British never find unmixed favour in his eyes. From our incompetence in writing or speaking our own tongue, to general inferiority in everything, he has often lectured us, and he does it so nicely that we like him all the better for it. Indeed, few non-English men of letters have more unknown friends among readers than the author of this and a dozen other grumbles on the wrong-goings of Londoners. He says:—

> "British art is as lifeless as Teutonic; the triviality of most of it, and its dominant note of domesticity, are to be observed also in posters, which are chiefly devoted to things to eat, and things to drink, and things for household use. The brutal vulgarity of a London railway terminus, foul with smoke, is emphasised by the offensive harshness of the posters stuck on its walls with no sense of fitness and no attempt at arrangement. Oddly enough the poster

is still outside the current of decorative endeavours which has given us the Morris wall papers, the Doulton tiles, the Walter Crane book-covers, and the Cobden Sanderson bindings. So it happens in Great Britain that one sees but little mural decoration that is not painfully unpleasant. Even when the advertiser seems to have taken thought and spent money, his effort is more often misdirected than not.

"Thus a firm of soap-makers has plastered up all over London, and in a printed gilt frame, an elaborate chromo-lithographic fac-simile of an oil painting by Sir John Millais, of which the merits, such as they are, are purely pictorial, and in no wise decorative. As a great price was given for this painting, and as the reproduction was obviously costly, attention was no doubt attracted to the soap-makers, and so the purpose of the advertisement was attained; but no artistic interest was subserved. The same firm of advertisers was better advised when it procured from Mr. H. Stacy Marks a simple black and white sketch showing two monks washing themselves with the soap to which attention was to be attracted. Thus it is in Great Britain in matters of art; good work is ever sporadic. There is no healthy organisation and no development in England as there is in France; individual posters may be commonplace, or distinguished, or ugly, as luck will have it, and one suspects that public opinion rather resents than welcomes the stronger effort."

One may fancy that Mr. Matthews would not have written such a sweeping condemnation, unless he felt he could turn to contemporary American work as contrast; and he goes on to claim—

"That the modern American poster (of 1892) is a form of mural decoration wholly unlike anything that has existed before; that it is founded on a thorough knowledge of design and harmony of colour, and of the technical possibilities of lithography."

As I chanced to spend twelve months in New York at that time, I can say, without prejudice, that—so far as delicate colour and pleasant detail are concerned—the American posters were ahead of ours. But—and it is a defect of no little moment—without exception, the figures at that date appeared to have been carefully enlarged from photographs and tinted, placed on white backgrounds, and very tastefully decorated with lettering far above the average, and with conventional ornament good of its sort. Now, as you will see by examples here, they have changed all that.

One of the Kiralfy shows at Olympia—Venice, if memory may be trusted—was advertised by many posters of this class. But to-day America has abandoned the type that ruled in 1892, and out-Herod's our wildest extravagance. Aubrey Beardsley who has not issued half a dozen posters, has influenced many of those young Americans, and Grasset a large number of the rest. But another type—hitherto used almost exclusively for the monthly periodicals—is far more original in the best sense, although it is modelled upon old Japan and modern France in equal proportions.

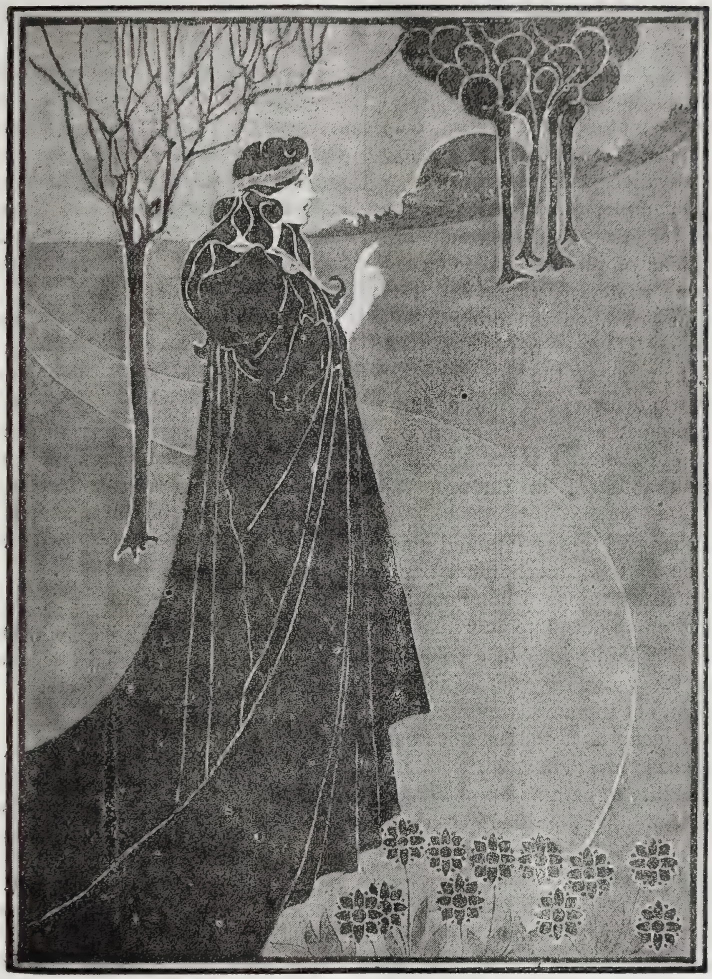
But destructive criticism is easy enough and it is pleasant to turn to the various qualities which should be present in a good poster.

First, I think (whether considered from the point of view of designer or merchant) is a striking idea. One that shall be distinctive and applicable to its purpose. One that is capable of being expressed in simple fashion, and does not depend upon subtleties of facial expression, or a mass of subordinate detail.

Next it is desirable that, both for economic printing and decisive effect, colour should be used in bold flat masses. The old axiom that opposing colours are rendered harmonious if separated by a line of gold or black, need not be unduly insisted upon. The best modern designers—who rely on flat colour effects—often employ outlines of black or white to define the forms, and prevent the unpleasant juxtaposition of discordant pigments.

In short, the poster should not be considered as a picture, but as a mural decoration; and in England, especially for frescoes, mosaic, and other forms of permanent embellishment of the walls of buildings, artists of all schools prefer a stern and conventional treatment.

But the most essential factor is the lettering; for the vital point in a poster is the message it proclaims, and here no difference of taste can affect the question. Legibility and symmetrical arrangement of the words must needs be accepted as the governing ideal of the various styles. This is a point of the very highest importance, one that, so far, has often escaped our modern designer. Whereas most of the Chéret posters owe their lettering to other hands; here, at times, the matter has been left to the artist. But he has not always been successful. Certain hideous and eccentric alphabets are still too popular. But if you turn to posters displayed here, many will be found irreproachable in this respect. True a very beautiful design, with one of the very best examples of lettering—Mr. Anning Bell's Liverpool School of Art poster—is not very legible; but we must remember it was a poster for a few, and these few presumably educated people. For those who contemplate a professional course in the arts, may be supposed to loiter and read its legend at leisure; but the still more unusual designs for the Glasgow Institute of Fine Arts show peculiarly clear and easily-read lettering. On the other hand, the lettering for the English edition of Steinlen's "Cats" is admirable in every way.



"THE SUN" (AMERICAN). A Poster by Louis J. Rhead.

[A series of lantern slides were then shown, nd the following remarks on some of them vere made by Mr. Gleeson White.

Although, as you will see presently, there re French posters of the accepted type long efore Fred. Walker did his famous "Woman White," this may be taken as the first rtistic poster attempted in our own country. r, to be more accurate, the first one that is istinctly the ancestor of all others, for Mr. alter Crane—always alive to the improve-ent of the common objects of daily life—had produced a design to advertise certain lead pencils, and Mr. Godfrey Durand had also attempted the pictorial advertisement before Walker. But Walker's poster is so good, that even to-day it holds its own. Done in a single colour—black, and admirably cut on wood by Mr. W. H. Hooper, it is accepted as the first, and, possibly, the best English poster ever designed.

Mr. Walter Crane, some years after his first attempt, produced several others—one for Covent-garden, which I have not been able to trace; one for the Paris Hippodrome at

Olympia; and one for a show of his own work. To him also belongs the credit of being one of the earliest—most probably the first—English artist whose work was commissioned for foreign use. This champagne poster, although of small size, is certainly not the least beautiful of those we are discussing to-night.]

If we accept the theory I have advanced, that posters should be considered as mural decorations—not as pictures self-contained in their interest—then it is instructive to see how English art has advanced in recent times.

Compare, for example, the mosaics in the morning chapel of St. Paul's—which are merely tame replicas of pictures, in no essential detail (save material) differing from chromolithographs—and, on the other hand, Professor Richmond's latest decorations for the roof of the choir, where the mosaic effect is insisted upon, where every accident of light is turned to the utmost account by arranging the facets of the tesseræ set at angles to catch the rays that steal in through the window.

There, as in other arts to-day (stained glass or stencilling) you find the mechanical limits not merely accepted as things which need not to be hidden, but emphasized to increase the peculiar effect. The limitations of a coloured lithograph for outdoor use may not be as palpable at first sight, but the more you study the matter, the more clear is it that a mosaic of fairly large patches is most effective.

Upon the possibility of permanent posters in coloured bas-relief or other dignified materials, time forbids me to dwell. In Paris it has already been tried, some by a lady, Madame Yeldo, as illustrated in Maindron's new book. Yet we can but hope that the spirit which is beginning to animate the poster, may be extended to the permanent advertisements on all walls and signboards, and that in place of the huge letterings which destroy the scale of a building, we shall find good panels of decoration with clear, though not overwhelming, gigantic legends to proclaim their particular purpose. But the subject has not escaped the attention of English artists. Possibly Mr. Harry Bates's admirable panels decorating a confectioner's shop facing the Kensington High-street may be forerunners of others. For where can art and commerce meet so fittingly as in the field of the poster permanent or ephemeral.

Every day sees new or tentative attempts, a few innovations, daring and entirely uncompromising. Men so shrewd as Sir Augustus Harris are willing to try the latest devices; indeed, the *impresario* of Drury-lane has surpassed his previous records by the admirable posters for this year's pantomime. But every day, we fear, sees timid advertisers trying to steer between the old and new schools, and the efforts to amalgamate the two are often ludicrous enough.

To repeat in brief the essentials of a poster, it seems to me that they are:—First, *a clearly defined pattern with a clearly defined purpose;* next, *an equally clear and distinctive scheme of colour limited for economic reasons;* and thirdly, but equal in importance—if not, indeed, more essential than the two others—*legible and well-placed lettering.*

So that these three are obtained, one fancies that everything else—good drawing, good lithography, and even good taste—are secondary qualities.

But all the same, very few things in this world are so simple that the bare essentials suffice; and no matter how fully a poster fulfils the three qualities placed first, it will fulfil them still more adequately if it also obeys the laws of the second three.

The following posters—many kindly lent by Mr. Ernest Hart—were exhibited on the walls of the lecture-room and in the vestibule:—

English.

Beardsley, Aubrey.—Yellow Book—Pseudonym—Children's Books—Avenue Theatre.
Bell, R. Anning.—Liverpool School of Art.
Beggarstaff Bros.—The Hour—Harper's Magazine—Cinderella.
Byles Hounson.—Dramatic Company.
Ffoukes, Chas.—The Century Magazine.
Fowler, Robert.—Autumn Exhibitions, Liverpool 1894, 1895.—Kirkland's Café.
Grieffenhagen, M.—Pall Mall Budget.
Hardy, Dudley.—To-day.—St. Paul's ("See-saw.") Cinderella.
Macdonald and McNair.—Design for a poster—Glasgow Institute.
Mackintosh, C. R.—Glasgow Institute—Design for a poster.
Morrow, A.—Illustrated Bits.
Poynter, Sir E.—Fire Insurance.
Quested, B.—"Property."
Raven Hill.—"Pick-Me-Up."
Solon, Leon.—"The Studio"—"The Frogs of Aristophanes."
Ward, Alfred.—Three designs for posters.
Warren.—Leeds Exhibition.
Whitburn T.—The Footpath.
Wood.—"Dr. Nikola."

Woodroffe, Faul.—Savoy design.
Wylie, W. L.—Orient Line: At Algiers—Off the Eddystone.

AMERICAN.

Abbey, E. A.—Quest of the Grail.
Bradley, Will H.—Chap. Books—Two Dancers; Girl iu Blue; Knight and Lady; "May;" Child's Head; Winged Horses—"Narcoti" "When Hearts are Trumps"—"Echo."
Carqueville, Will.—June, Lippincott's—January, Lippincott's—February, Harper's—September, Lippincott's.
Clarke Scotson.—Recorder—Yellow Girl—Black Girl—Bookman.
Cox, Kenyon.—Scribner's Magazine.
Dow, A. W.—Modern Art.
Edwardes, G. W.—Century: Girl and Poppies.
Loury, M.—Century Co.
Nankwell, N.—The Echo.
McCarter, H.—Green Tree Library.
Penfield, Edward.—Harper's—March, October, September, August.
Rhead, Louis J.—The Sun—Red and blue rays; girl in red robe; winter, blue girl; winter, red girl; yellow and green figure—Packer's Tar Soap.—Morning Journal—Two girls in red; two girls in green.—Pearline—Lindborg's Perfumes—Prang's Postal Calendar; Cards.—Century—Girl and Sunflower; Girl with roast Peacock.—"Tribune."
Sloan, John.—Echo—Moods.
Sloan, Marianna.—The Press.
Smith, Curtis.—"Ladies."

FRENCH.

Anquetin.—Le Rire.
Bounard.—France Champagne—La Revue Blanche.
Chéret Jules. — Aux Buttes Chaumonts—Museé Grevin—Loïe Fuller (4)—Ed. Sagot.
Caran d'Ache.—Exposition Russe.
Grasset.—Joan of Arc.
Ibels, H. G.—L'Escaramouche—Irene Henry.
Lautrec, H. de T.—Bruant—Confetti—Caudieux.
Lunel.—Cycles.
Orazi.—Theodora.
Steinlen.—Yvette Guilbert—Nestlé's Milk.
Vuillard, C.—Beccante.
Willete.—Van Houten's Cocoa—Ditto.

Van Hoytema.—Railway Bill.
Munich.—Anonymous Poster.
Sattler, J.—Pan.

DISCUSSION.

Mr. JOHN LEIGHTON said he had been much pleased with the paper, and especially with the illustrations shown on the screen, some of which were quite new to him. Two or three years ago when he lectured on the subject, he got a few specimens together, just as they came, good and bad, but there was not such a collection as that now shown. The great drawback then was the glaze upon many of the posters. Posters were now getting so large that it was almost impossible to make a collection of them. Twenty years ago and more, when the *Graphic* was started, he designed the title page, which was used to this day, and it was copied for *La Vie Moderne*, or some such work in Paris, and an enlargement was made for a poster, which he believed was rather a susprise to the people of Paris. There was a large association with a powerful committee which was adverse to posters as they existed, or perhaps he should say as they did exist until recently, for he really thought some of the members might be converted if they could see this exhibition. Nothing could be more beautiful than the process of building a house, but nowadays it was entirely hidden from view by an enormous hoarding, and he sincerely hoped the County Council would keep these down to a height of ten feet.

Mr. LEWIS DAY said he had listened with great interest to Mr. Gleeson White's paper, and had learned a good deal from it, especially with regard to the French poster designers, who certainly seemed to have taken the lead in this direction. He could not profess any great admiration of the poster in general, and did not believe much in its artistic possibilities. There were artistic posters it was true, but he doubted whether they could ever be very numerous, because the whole art of advertising consisted in shouting, and the whole struggle was which could shout the loudest. When other people did not shout a man might call attention to his wares by a more or less musical cry, but when everyone shouted there was nothing for it but noise. In old days there were street cries which were picturesque, but the poster was, now-a-days on a par with the big drum of the showman at the fair, or the shriek of the steam whistle, to which the showman now resorted as a more excruciating form of advertisement. He had not much experience of posters, but had had a good deal to do with designs of advertisements: he began with great faith in the possibility of putting art into advertisements; but he had lost it almost entirely. He was more and more impressed with the absolute stupidity of advertisers in general; as a body they not only lacked taste but common sense. They could not be converted from the belief that the bigger anything was written the more legible it was; and if you could put an impossible shadow to the lettering, and varnished it so as to make it shine they liked it all the better. They could not learn that it was not wise to tell everything you had to say; each one wanted to tell you everything, to have a picture of his works, and a portrait of himself, and all sorts of things deeply interesting to him, but about which the public did not care a button. In fact, he thought most advertisements were calculated to repel rather than to attract. Mr. White spoke of a feeling of irritation as being calculated to excite attention; that feeling might go so far as to make one vow never to purchase anything which was advertised. A flat treatment for posters undoubtedly seemed most practical; it was itself attractive, if bright, fresh colours were employed; and it was economical. But advertisers would not, as a rule, believe anything was good unless it had what they misconceived to be finish. Chéret's posters, apart from their objectionable Frenchiness, were most wonderful examples of direct and practical lithography; and one great reason of the artistic charm of his work was that he was himself a lithographer, and probably put the work on the stone direct. In the ordinary way the advertiser wanted to see a finished sketch first, which had to be put upon the stone afterwards by some lesser artist, and the money that might have been spent upon art was wasted upon mechanism. Some of the examples of recent posters upon the walls were amusing. Designs might be absolutely incoherent; but if only they were startling, to that extent they might fulfil the object of the poster.

Mr. HARRISON TOWNSEND said the point in the paper which partly appealed to anyone who, like himself, had just returned from a visit to Egypt and Constantinople, was the similarity in aim and object of the ancient worker in mosaic and the modern advertisement designer. They each had to convey a simple and short message in the fewest possible words. The old mosaic worker did it, and the modern advertisement designer strove to do the same thing by the elimination of everything which conflicted with simplicity of statement. Neither of them dealt, or should deal, for instance, with atmospheric effects, nor should either appeal to the emotions so much as to the intellect. Those who wished to see this connection between two widely different arts and periods, could do so at their next visit to the South Kensington Museum, where, in the Italian Court, were some 5th and 6th century mosaics from a church in Rome. There they would see the black outline and the use of three colours to tell a simple tale, just as the designer of an advertisement wanted to convey one leading idea in the shortest possible phase.

Mr. JOSEPH PENNELL said he had never designed any posters, though he understood that some had been prepared for advertising his own work, and that they had been stuck on the walls, and that all France and America had thus been made gay, without his knowledge or consent. It seemed to him that Mr. Gleeson White had proved conclusively that there was no distinct art in posters, and that the separate classification was an absurdity. On looking round the room, the most effective posters were those made by people who knew nothing at all of the subject as a specialty. For instance, the one by Steinlen was nothing but the enlargement of one of his ordinary drawings in *Gil Blas*, whereas the specimens from Glasgow, though no doubt they answered their purpose, were the most ill-begotten, ill-conceived set of things he ever saw in his life; there was no drawing, no lettering, no colouring, no anything, except stupid eccentricity, which might make the vulgar gape. The end of the Glasgow school was truly pitiful. The one decent design in which drawing and lettering were well put together, was extremely ineffective. There were several for the *Century Magazine*, on which he had been working for several years, and in which some of his own work had been used; but on one of these posters there was the figure of Joan of Arc, or some unknown creature, with a wiggle-waggle flag streaming over a yellow back-ground; and he would defy anybody to tell what it meant; how it explained or advertised an American magazine. Again, on another of the American designs, there was a young lady in red skating along in front of a bright green field, with snow and ice upon it, and the lettering was as bad as you see in any halfpenny paper, as a notice of children, sliding on the ice all on a summer day. It was admirable, if ridiculous; the most utter rubbish, which you could not sell as drawings or illustrations, seemed good enough to be stuck on the walls as posters; in fact, to judge from the exhibition, to design a decent poster, one should put aside all common-sense. There was one ridiculous one, advertising the *Studio*. A young lady in yellow, with a black pallette—a thing utterly unheard of—was holding a brush in her hand, which had burst into flame from the intensity of the divine fire which emitted from it. Mr. Dudley Hardy's best works were not exhibited, possibly because he is the only intelligent designer. He really thought there was more abominably bad work stuck on the walls than it would have been possible to produce. He did not think, therefore, there was any art in the poster *per se*. Chéret had gone on turning the handle of the organ which he had been grinding for years; it was always the same female figure, standing on one or the other leg, or holding a flag or something else in the other hand, and he did not think there was any advance in his work at all; but Steinlen had advanced. Willette's cocoa advertisement was almost the only one in which a man accustomed to real artistic work had set himself to adopt his art to the purpose of a poster. Lautrec and Ibels were fine, but they are fine draughtsmen. Bradley appeared to have got everything he knew from Beardsley, except sense; and Beardsley was himself. There was no art of poster designing as yet; you simply wanted a man who could make a good design for any ordinary commonplace thing, and then enlarge it and it made a good poster, providing the lettering were good, and the design intelligent, which it generally was not.

The CHAIRMAN, in proposing a vote of thanks to Mr. Gleeson White, said one of the chief merits of this admirable paper was that it had educed the extraordinary observations of Mr. Pennell. He did not think he had ever listened to anything so picturesque, so strongly worded, and which so completely refuted itself; for while, on the one hand, Mr. Pennell told them his objections to many of these things, on the other hand he emphasised his admiration for really good posters, and pointed out several which were examples of admirable art. Art was not elevated or degraded by the poster, and to say that it was ordinary art applied to a highly decorative purpose, was, in fact, the highest possible praise. One of the greatest purposes of art was decoration, and now-a-days, when, however much it might be deplored, advertising was one of the most important phases of modern life, and one of the most palpable necessities of modern competition, it was in the highest degree desirable that decorative art should take its proper place in this as in the other ordinary purposes of life. They did not spend all their lives in churches or art galleries, but largely in rooms and in the streets, and he could not conceive any more legitimate field for artistic skill than the street poster; and he believed that work such as that of Grasset, Chéret, Lautrec, Steinlen, Dudley Hardy, Beardsley, and others would have a development and an effect long after a good deal of the art which was produced for purely art purposes was forgotton. In his view, to get the best results in this direction they must go back to the earliest and best tradition—to the great tradition of Japan. There you had a thoroughly artistic and decorative people, who practised the greatest economy of method and simplicity of colour. They worked by hand, and those Japanese chromolithographs and xylographs, which were the admiration of the artistic world, were for the most part nothing but posters, New Year cards, and advertisements, in two or three colours. Nearly all the work of the Utamaro, and Shunshó, which were now becoming priceless, were advertisements of actors, of beautiful women, or of things for sale. They were executed in the decorative spirit in which the best of modern posters were executed, and they constituted a landmark in art.

The vote of thanks having been carried unanimously,

Mr. GLEESON WHITE, in reply, said if it were true, as Mr. Day suggested, that the advertisement took the place of a steam whistle, still if there were a dozen steam whistles going at once, it would be much better that they should be in tune. Mr. Townsend referred to simplicity of statement, in which he was quite correct. One of the most effective sentences on any poster merely said "Will not wash clothes," and did not tell you anything else. Mr. Pennell, as usual, had cleared away the fog, and gone straight for the facts. He had betrayed the artist's indignation at the commonplace in which most would agree with him, but if there were good art in a poster, whether it got there by accident or design, still it was art; and many who would never have an opportunity of admiring a drawing of Steinlen in *Gil Blas*, could do so on a poster. In conclusion, he desired to return his best thanks to the Chairman for the loan of some of the best examples of the French school, and also to Mr. Bella. He had not selected the specimens because they were the best posters by any means, or even as being the most typical, but because they were likely to be unfamiliar to the audience, as very few of them were at the present time on London walls and hoardings.

SIXTH ORDINARY MEETING.

Wednesday, January 15, 1896; LORD REAY, G.C.S.I., G.C.M.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Arnot, J. Melrose, Bally, Uttapara, near Calcutta, India.
Burrell, Frederick John, St. Mary's-house, Thetford, Norfolk.
Butler, Matthew Joseph, Bay of Quinte Railway, Deseronto, Ontario.
Clerk, Dugald, 13, Temple-street, Birmingham.
Davies, Theophilus Harris, J.P., Sundown, Hesketh-park, Southport.
Dodd, John, J.P., The Hollies, Werneth, Oldham.
Dunn, Edmund Richard, 90, Queen-street, Ramsgate.
Evans, Richardson, 1, Camp-view, Wimbledon-common.
Gerrans, Henry Tresawna, M.A., Worcester-college, Oxford.
Ghasvala, B. E., Government Laboratory, Byculla, Bombay, India.
Hansford, Charles, 3, Alexandra-terrace, Dorchester.
Holditch, Colonel Thomas Hungerford, R.E., C.I., The Park, Simla, India.
Holmes, James G., Thorne-lodge, Oakfield-grove, Clifton, Bristol.
Hutchinson, J. T., Aden-house, Bury, Lancashire.
Mulliner, Herbert H., Pneumatic Tyre Company, Limited, 14, Regent-street, S.W.
Purdon, Henry Atwell, Aguilas, Provincia de Murcia, Spain.
Swinburne, James, 66, Victoria-street, S.W.
Vernon, Hon. Forbes George, 39, Victoria street, Westminster, S.W.
Wyman, John Sanderson, 22, Nottingham-place, W.
Young, Edwin, 2, Gordon-terrace, Hamilton-road, Brighton, and County-hall, Lewes, Sussex.

The following candidates were balloted for, and duly elected members of the Society:—

Allison, Charles Arthur, 52, Chancery-lane, W.C.
Bosanquet, Charles John, Ripley-lodge, Belvedere, Kent; and 73, Queen Victoria-street, E.C.
Evans-Jackson, J. E., 45, Holborn-viaduct, E.C.

Oppermann, Carl T. J., 57, Wray-crescent, Tollington-park, N.

Plater, Captain Henry Robert Frederick, 18, Campbell-road, Bow, E.

Smallman, Frederick, Hayesleigh, Stretford, Manchester.

The paper read was—

THE MAKING OF A GREAT UNIVERSITY FOR LONDON.

By Silvanus P. Thompson,
B.A., D.Sc., F.R.S.

It is fortunate for me that the title of my paper was sent to the Secretary of the Society of Arts before the appearance in the *Nineteenth Century* of November last, of Lord Playfair's remarkable article on the same topic. Otherwise I should have had to content myself with the part of a mere echo. But those who have followed during the past ten years the many and varied efforts towards university construction in London will forgive, even at the risk of repeating words that have been spoken so well and wisely, the attempt to review some of the larger issues in the question, issues which have of late been perhaps somewhat obscured in petty questions about vested interests and the quarrels of quasi-politicians.

To the future historian of England it will probably appear one of the strangest features of the intellectual life of the Victorian era, that while there flourished a great university in the capital of every European State, and in many other European cities, while true universities arose in all the most important cities of the United States, of Canada, and of our Australian colonies, and even in far Japan, the only body possessing the right to call itself a university in London was in the strict sense not a university at all but a mere examining Board.

In order to have some standard of comparison, let us look at some of the great universities in other cities. Small universities like those of Giessen, Rostock, or St. Andrew's —famous though they are—need not be dealt with. But name any of the great universities, Oxford, with its supreme reputation as the home of classical learning, and Cambridge, its great mathematical rival; Edinburgh and Vienna, with their splendid medical schools; Paris, with its great law schools, its Sorbonne, its Collège de France, its splendid array of laboratories; Strassburg, with its scientific institutions, rivalled only in Europe by those of Berlin, Paris, and Leipzig; Dublin, with its double reputation in mathematics and classics; Tübingen, Heidelberg, Bologna, each with a reputation for greatness in one or other faculty; the great modern American universities, of which Harvard University is only one type, while the Johns Hopkins University, of Baltimore, is another; lastly, the great Imperial University of Tokio. What is it that makes each and all of these truly a great university? Not antiquity, for some of them are essentially modern; not their residential halls or colleges, for residential halls are the exception; not athletic sports, for some of them are practically devoid of these; not severity of examinations, for in some of them the granting of a degree goes by tests far other than the answering of examination papers; not the number of degrees granted, nor even the numbers of students on their register, though these things may witness to a greatness, and are its effect, not its cause. No; their greatness depends on the measure in which they are fulfilling the true and essential functions of a university as the home of learning, the promoter of scholarship and research, the centre for the material and personal diffusion of knwledge, the focus in which human life and thought are concentrated for the advancement and acquisition of knowledge. What they are they are made, not only by the possession of libraries wherein are stored the treasures of past and present wisdom, of museums for the preservation of collected specimens, of buildings for lectures and class-rooms, and of laboratories for the study and discovery of physical laws—these material possessions they all must have—but by the presence and influence of living minds, of active intellects, in a word, by their being literally homes of learning. In the great university you will find the great teacher; and to the great university goes the student who will one day be the great scholar or the great thinker. A commonwealth of learning, a true *universitas litterarum*, can only flourish where both kinds of possessions, material and human, are brought together. No mere college—whether that term be a applied to a building or to a collection of men—no mere organisation for teaching, certainly no mere system for testing knowledge, can be considered in itself as a university. The primary function of a university is not to establish residential colleges. nor yet to examine. Its function is not even primarily to teach. Learning, not teaching, is that which is primarily the essential, and any university which does not promote learning, both with adequate material and personal equipment, is misnamed. In the short closing summary of his book on the Universities of Europe, Mr. Rashdall sums up this point in the following terms:—

> "The two most essential functions which a true university has to perform, and which all universities have more or less discharged, amid the widest possible variety of method and organisation, hardly excepting even the periods of their lowest degradation, are to make possible the life of study, whether for a few years or during a whole career, and to bring together during that period, face to face, in living intercourse, teacher and teacher, teacher and student, student and student. It would be a fatal error to imagine that either the multiplication of books or the increased facilities of communication can ever remove the need of institutions which permit of such personal intercourse."*

It is, therefore, from the point of view of the scholar, whether he be nominally student or nominally teacher, that the claims of a university to be considered great must be decided. Does it bring him into an atmosphere of mental activity and progress? Does it afford contact with living thought? Does it give the stimulus of intellectual struggle so essential for improvement of knowledge? Does it furnish the means and appliances of learning? Does it provide the scholar with libraries, and give him access to the mental furniture of the past and of the present? Does it offer to the investigator the means of pursuing research? If it does, then it is fulfilling its functions as a university. The test of greatness is to be found in the degree to which it thus ministers to the intellectual progress of the age.

Let us turn to the material and financial aspects of a great university. The statistics must be given very imperfectly; but they suffice to afford a general view. In the Table, pp. 182 and 183, are given, on such information as is available in Blue-books and in that marvellous compendium, "Minerva," a few data concerning 26 different universities, including those already named. Imperfect as any such tabular information is, it will serve to bring out the main issue. In order not to overload it I have omitted some even of the largest European universities, as those of Naples, Munich, Buda-Pesth, Prague, and others. It will be most convenient to consider in succession the several points raised.

FINANCIAL POSITION.

The income of the two universities of Oxford and Cambridge is a little over £60,000 per annum each, towards which in neither case does the State or the municipality contribute. Of these sums the colleges contribute at Oxford £6,700, at Cambridge £21,500. But the incomes of the colleges themselves are far greater than that of the university. The endowments and emoluments of the 20 colleges at Oxford (not including the five halls, or the three women's halls) amount to about £250,000 per annum, while those of the 17 colleges of Cambridge (not including the three halls or the two women's colleges) amount to about £282,000. As the number of undergraduates and graduates in residence may together be approximately taken as 3,700 and 3,400, at Oxford and Cambridge respectively, it follows that the gross sums expended on each student are at Oxford £84 per annum (£17 by the university, £67 by the colleges), and at Cambridge £102 (£19 by the university, £83 by the colleges).

The income of the University of Edinburgh, with 2,924 students, is £88,000, while its more favoured sister in Dublin, with about one-third as many students, is £70,000. The University of Paris has an income of £150,000 a year, that of Berlin, founded in the lifetime of men still living, £130,000, that of Vienna £109,000. Leipzig and Strassburg have respectively £90,000 and £50,000. The total income of the 21 universities in Germany is about £1,130,000 per annum, of which about £786,000 is contributed by the State. This exceeds £20 per student; but it should be remembered that over 40 per cent. of the disbursements go to the maintenance of laboratories, libraries, museums, and other institutes. The smaller German universities, such as Bonn, Erlangen, Heidelberg, Königsberg, Jena, &c., have incomes varying from £58,000 down to £21,000, while the smallest two, Rostock and Munster, have £16,000 and £13,000 per annum respectively; the former receiving State aid worth £36 per student, and the latter with about £9 per student. Bologna, the oldest European university, has an income of £30,000 and 1,457 students. Padua, with a larger number of students, has £26,000. Upsala, with 1,495 students, has an income of £40,000, mainly derived from property, only £9,000 being a State subvention. Graz (in Styria) has 1,552 students, and an income of £19,800, almost wholly derived from the

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* Rashdall, "Universities of Europe in the Middle Ages" (1895), vol. ii. p. 714.

	Gross Income.	State or Municipal Subvention.	No. of Students.	Income per Student.	State, &c., Subvention per Student.	No. of Professors and Assistants.
	£	£		£	£	
Paris	150,000	?	11,233	13	?	300 +
Berlin	130,000	105,000	8,652	15	12	179 + 174
Vienna	109,000	104,000	6,714	16	15	159 + 190
Oxford { University	63,761	—	3,200 (undergrads.)	19	—	70 +
Oxford { College	250,000			77		
Cambridge { Univ.	65,550	—	2,900 (undergrads.)	22	—	80 +
Cambridge { Coll.	282,000			97		
Harvard	260,000	—	3,783	69	—	149 + 188
Leipzig	90,000	70,000	2,957	34	23	134 + 65
Edinburgh	88,142	29,752	2,924	30	10	90 +
London	21,000	Pays to State 3,073	2,225	2	Pays to State 30s.	—
Cornell	105,000	7,000	1,686	62	4	77 + 80
Padua	26,800	?	1,672	16	?	62 + 60
Graz	19,800	18,600	1,562	13	12	83 + 28
Upsala	40,000	9,000	1,495	27	6	122
Bologna	30,000	?	1,457	20	?	70 + 81
Heidelberg	38,400	34,500	1,428	27	24	96 + 25
Tokio	70,000(?)	?	1,396	50 (?)	?	123 + 31
Tübingen	45,000	43,000	1,262	36	34	69 + 15
Dublin (Trin. Coll.)	70,000	—	1,124	62	—	35 +
Strassburg	50,000	46,000	1,030	48	44	88 + 32
Greifswald	39,000	14,000	891	43	17	64 + 22
Zürich*	30,000	25,000 (?)	822	36	30 (?)	61 + 56
Leyden	62,200	?	815	76	?	50 + ?
Königsberg	49,000	41,000	756	66	55	70 + 32
Giessen	38,000	27,000	598	63	45	55 + 8
Baltimore	35,000	—	589	59	—	42 + 42
Rostock	16,000	15,000	420	38	36	42 + 3
St. Andrews	11,972	6,035	199	60	30	15 + 4

* This does not include the Polytechnicum, which has an income of £36,000, of which £30,000 is a subvention from Government, and which has 1,235 students, and spends £6,500 a year on its Laboratories for Chemistry, Physics, Engineering, &c.

Average Number of Students per Professor.	Number of Professors and Assistants per hundred Students.	Total Salaries of Teachers.	Total sum spent on Museums, Laboratories, Observatories, and Institutes per annum.	Total Sum spent on Library per annum.		Number of Books in Library.	Number of Books Borrowed from Shelves per Annum.
				Staff.	Books.		
		£	£	£	£		
37	2·7 + ?	116,000	34,000	4,100	2,700	141,700	—
48	2·1 + 2·0	34,000	73,000	1,600	950	142,000	—
42	2·4 + 2·8	25,000	12,600	1,080	930	454,953	317,000
45(?)	2 2 + ?	?	12,000	4,762	5,238	500,000	—
36(?)	2·7 + ?	?	9,000	4,000	2,040	500,000	—
25	4·0 + 5·0	101,000	88,000	4,200	5,000	104,000	—
22	4·5 + 2·2	46,000	24,500	2,000	2,500	500,000	—
32	3·1 + ?	48,000	19,000	1,012	1,400	178,000	—
—	—	—	199	?	100	25,000	450
22	4·5 + 4·7	54,000	21,300	7,600		178,000 + 30,000 *p.*	—
27	3 7 + 3·6	20,000	4,800	1,000	400	136,000 + 65,000 *p.*	29,900
19	5·3 + 1·8	10,000	9,000	2,200		137,300	54,000
12	8·3	24,300	8,900	1,200		280,000 + 50,000 *p.*	39,000
21	4·7 + 5·5	20,000	9,000 (?)	680	400	255,000 + 48,000 *p.*	21,342
15	6·6 + 1·8	23,000	13,000	?	800	400,000 +175,000 *p.*	57,000
11	9·1 + 2·1	25,000(?)	?	?	?	188,000 +100,000 *d.*	427,000
18	5·5 + 1·2	20,000	23,000	?	700	320,000	39,000
32	3·1 + (?)	?	?	?		221,500	—
12	8·3 + 3·1	26,000	16,000	2,800	2,950	700,000	—
14	7·1 + 2·4	13,000	19,000	1,000	2,000	148,000	18,407
13	7·7 + 6·8	9,500	3,500	[1,150]		Use of Town Libraries, with 204,000 volumes.	—
16	6·2 + (?)	33,000	4,680	445	780	190,000	—
11	9·1 + 4·3	15,000	25,000	1,300	1,370	220,000	32,000
11	9·1 + 1·3	13,000	22,000	570	900	70,000	15,200
14	7·1 + 7·1	?	10,300 (?)	?		70,000 + 30,000 *p.*	—
10	10·0 + 0·7	7,900	5·500	400	1,030	307,000	20,000
13	7·7 + 2·0	10,000	?	630		115,000	—

p. Pamphlets. *d.* Duplicates.

State. The University of Leyden, having only 815 students, has an income of £62,200 a year, or nearly £70 per student.

Turning to America, we find Harvard University with an income of £260,000 a year, of which about £95,000 is the income of its residential college. In receipt of continual new endowments and bequests, it needs no State subvention. Its private property is valued at £2,400,000; and, in 1894, no less than £25,800 was received as gifts to its funds, besides £10,700 more for special purposes. It has 3,700 students. Cornell University, though only founded in 1865, is already a great university. It has 1,686 students, an income of £105,000, and a splendid array of buildings and institutes. Baltimore University ("Johns Hopkins"), so famous for research, was founded in 1876. Its income is £35,000, and its students number 589. Lastly, the Imperial University of Tokio, founded in 1868, with an income believed to be not less than £70,000, mainly derived from the Imperial treasury of Japan, has 1,396 students. The "Faculties" scattered up and down France, and which take the place of local universities, have incomes varying from £40,000 at Lyons, and £35,000 at Bordeaux, to £13,000 at Dijon and £12,000 at Grenoble.

NUMBER OF STUDENTS IN ATTENDANCE.

It is difficult, in some cases, to state precisely the number of students at a university owing to the returns not making a distinction between students pursuing a regular course and casual students taking single sets of lectures. It will be noted that Paris and Berlin head the list with 11,000 and 8,600 students respectively. Vienna comes next with 6,700; Naples has 5,000; then come Harvard, Oxford, Cambridge, and Munich, with about 3,700 each; while Edinburgh, Leipzig, Buda-Pesth, and Prague, and St. Petersburg follow with about 3,000. There is a like number in the "Victoria" University, spread over the three colleges in Manchester, Liverpool, and Leeds. Yale University has 2,350; Glasgow, 2,080; Rome has just 2,000; Bonn, Cornell, Padua, and Halle have about 1,700. Graz, Heidelberg, Upsala, Freiburg, Würtzburg, Tokio, Coimbra, and Breslau continue the list to about 1,400. Tübingen, Brussels, Erlangen, Dublin, Genoa, and Strassburg bring the numbers down from 1,300 to 1,000. Below 1,000, though certainly entitled to be called great, come Baltimore, Leyden, Aberdeen, Königsberg, and Göttingen. The lowest German university being Rostock, with 420; the lowest British—Durham and St. Andrew's—with 400 and 200 respectively. (I omit the University of Wales as too new to consider, and the University of Lampeter as too insignificant to be of account.) The larger of the provincial "Faculties" of France—Lyon and Bordeaux—have about 2,000 students each, and therefore rank with Yale, Glasgow, Cornell, and Halle. Toulouse (formerly a university in its own right) has 1,560; Lille has 1,450; Nancy, 1,000; Grenoble and Dijon about 100 each.

PROFESSORIATE.

In comparing statistics, it must be borne in mind that in some universities many of the readers and lecturers who do not bear the title of professor, are really doing professorial work. Paris, Berlin, Vienna, and Harvard head the list with 300, 179, 159, and 149 respectively. Then come Leipzig, Tokio, Upsala, Heidelberg, Edinburgh, Cambridge, Oxford, Graz, Cornell, Bologna, Tübingen, Königsberg, and Greifswald, with numbers running down from 134 to 64. The American universities mostly agree with the German and Italian in having large numbers of assistant-professors and privat-docents, the latter being lecturers without stipend, who have the privilege of using the university lecture-room when available, receiving fees from such students as voluntarily attend their courses. The number of professors relatively to the number of students varies greatly. In the universities of Oxford, Cambridge, Paris, Vienna, Berlin, Edinburgh, and Dublin there is one professor to every 30 or 40 students; while in those of Upsala, Tokio, Strassburg, Königsberg, Giessen, and Rostock, the proportion is one professor to 10 or 12 students. If privat-docents are included, the figures come out more favourably for the larger universities. At Berlin there are 4·1 teachers (professors and privat-docents) for every 100 students (or 1 to 25); at Vienna, 5·2 per 100 students; Leipzig, Padua, Graz, and Tübingen have 7 for every 100 students; Harvard and Cornell, 9; Padua, Greifswald, and Giessen, 10; Tokio, Strassburg, and Rostock, 11; Königsberg, 13; while the most strongly staffed are Zürich and Baltimore, with 14 teachers per 100 students.

The sums paid to the professors vary greatly; while a few of the leading professors in Edinburgh make £3,000 to £4,000 a year, their assistants are decidedly underpaid. Excepting the divinity professorships at Oxford or Cambridge, all other professorships in English universities and university colleges are much less highly remunerated. The average value of a university professorship in Europe—taking the assistant or extraordinary professorships along with the ordinary—appears to be about £300 per annum. But the higher professorships in the large universities are in general much more than this. For these an average of £800 would be more correct.

The highest total sum paid to the teaching staff is that paid at Paris, amounting to £116,000 per annum. Harvard pays £101,000, Cornell £54,000, Edinburgh £48,000, Leipzig £46,000, Berlin £34,000, Leyden £33,000. Rostock, with only 420 students, pays its professoriate £7,000 a year, while St. Andrew's, with 200 students, pays £10,000 to its teaching staff. London University having no university professoriate, pays nothing to any teaching staff.

PROVISION OF LABORATORIES, MUSEUMS, OBSERVATORIES, AND OTHER INSTITUTES.

The feature which characterises the modern university is its expenditure upon its special institutions for the study of the sciences. True, it has for centuries been the practice, in the faculty of medicine and surgery, to provide anatomical museums, as well as clinical institutes and dissecting-rooms, attached to the hospitals. But the growth of scientific laboratories, chemical, physical, pharmacological, botanical, physiological, and mineralogical, is of the present century. No modern university can be great that is not adequately equipped with institutes for the special studies of the several sciences.

In this respect Harvard University heads the list with its expenditure of £88,000 per annum upon its laboratories, museums, observatories and institutes; Berlin comes next with £73,000, Paris spends £34,000, Königsberg £25,000, Leipzig £24,000, Tübingen £23,000, Giessen £22,000, Cornell £21,000, Greifswald and Edinburgh both spend £19,000, Strassburg spends £16,000, Heidelberg £13,000; then—fourteenth on the list, though probably lower if some other universities Munich, Yale, and Columbia (N.Y), had been included—Oxford with £12,000, followed by Bologna, Cambridge, Graz, and Upsala. Even Rostock, with its 420 students, spends £5,500 per annum on its laboratories and collections. The University of London spends £199 per annum on its one laboratory; but no research is ever carried out there, no instruction is ever given there: it is used solely for examination exercises.

UNIVERSITY LIBRARIES.

What the laboratories, observatories, and scientific institutions are to the modern university, the library, with its manuscripts, books, pamphlets, and maps was to the university of olden time. But in the faculties of arts and of laws, if the library is indispensable in the study of letters and philosophy, it is also needed for the proper and full study of medicine and of the sciences.

The richest university libraries are beyond all doubt those of Oxford and Cambridge, each of which numbers about 500,000 volumes, without counting manuscripts and separate pamphlets, prints, or maps. Harvard has 448,000 volumes and 350,000 pamphlets. Strassburg has no fewer than 700,000 volumes; Leipzig, 500,000; Vienna possesses 455,000 volumes; Heidelberg, 400,000, and 175,000 pamphlets. After these come Tübingen, with 320,000; Upsala, with 280,000; Bologna, with 255,000; St. Petersburg and Dublin, with 230,000; Königsberg, with 220,000; Leyden, with 190,000. Tokio follows with 188,000 and 100,000 duplicates for lending. Edinburgh and Cornell each have 178,000. Greifswald has 148,000; Strassburg, 141,000; Berlin, 140,000. The library of the University of London has only 25,000 volumes.

The sums spent per annum on libraries are no less significant. In the figures which follow the annual sums spent on library staff and on the acquisition of books are lumped together; but it may be taken that in the larger universities just half or a little more of the whole sum is spent on salaries, while in the smaller less is spent on salaries than on acquisition of new works. Harvard leads the way by spending £9,200 per annum on its library; Oxford, £8,500; Cornell, £7,600; Paris, £6,800; Cambridge, £6,040; Strassburg, £5,750; Greifswald, £3,000; Königsberg, £2,670; Berlin, £2,550; Edinburgh, £2,412; Graz and Vienna, £2,000 each; Glasgow, £1,800; Giessen and Padua, each £1,400; Aberdeen, £840; St. Andrew's, £630. The University of London spends the magnificent sum of £100 per annum.

One other piece of library statistics may be of interest; that it can be given even fragmentarily is due to the indefatigable editors of "Minerva." It relates to the use made of the university libraries, and deals with the numbers of volumes borrowed from the shelves during the year (1894). With one exception, to be named presently, Vienna heads the list of those known, with 317,000 volumes used during the year. Next comes Harvard with 104,000; Leipzig, 57,000; Graz, 54,000; Upsala, 39,300, and a number of other German universities, down to Giessen, 15,200 (Giessen has 600 students). But besides those mentioned, there are two very surprising cases. At the actual head of the list stands the University of Tokio (with its 188,000 volumes and 100,000 duplicates), where the number of library entries of volumes taken down from the shelves amounts to 427,000 during the year. As its whole number of students and teachers combined is 1,550, this makes an average of 275 entries per person per annum. The number of entries of readers for the year is 68,000, so that on the average every student and teacher in the university has visited the library 43·9 times during the year, and on each visit has, on the average, taken out, or borrowed, 6·2 books. It may be, however, that the university library is used by other persons. Nearly half the volumes in the Tokio library are in European languages, the rest being in Oriental languages, mainly Chinese and Japanese. The other exceptional case is that of the University of London. Its undergraduates who are proceeding to degrees number about 2,100. Of these, about half live in, or within reach, of London. Its library of 25,000 books is not, however, much used by them or by the past graduates, of whom at least 1,000 reside in or near London. During the last year the number of works borrowed from its shelves was 450, the number of individual readers being about 40. My personal experience is that on the few occasions when I have wanted to go into the library to consult any work, admission has been barred by the circumstance that the room was being used for holding one of the examinations!

A university which has no professors, no museums, whose library is practically unused and unusable, in whose single laboratory no researches are ever made, which is doing no teaching, whose sole possessions are programmes for examinations, candidates to be examined, examiners to examine the candidates, and a building where the examinations are held, cannot be called a *great* university. Indeed, were it not for the arbitrary definition of that term as conferring the right to grant degrees it could not be called a university at all. It is fulfilling precisely the same sort of function as the Civil Service Commission fulfils. That body, like the University of London, is a State-created body. It has its candidates, its programmes, its examiners, its stringent rules for conducting examinations, its building for holding them. Its examinations are impartially open to candidates from all parts; and as a matter of fact the value of the appointments depending on them is vastly greater than that of any depending on the examinations of the University of London. The Civil Service Commission regulates, amongst other things, the official methods of spelling the English language. This highly influential body is denied the privilege of conferring degrees upon its most qualified candidates. Yet in the abstract it is just as completely and truly a university as the University of London.

But if the educational position of the University of London is thus entirely anomalous, still more extraordinary is its financial position. We have seen how large are the sums, whether derived from property, from fees, or from State or municipal grants, which all the great universities enjoy; and how essential such financial support is to their discharge of their functions. With the exception of the three great historic universities of Oxford, Cambridge, and Dublin, and the more recently created American universities, all universities, great or small, are in receipt of State aid, some almost entirely dependent upon it. Government, in one form or another, gives £29,000 a year to Edinburgh, £24,000 a year to Glasgow. To the University of Wales and its colleges the State grant is £15,000 a year. To the provincial university colleges of England it gives £15,000. To the Royal University of Ireland and the three Queen's colleges the total grant is £44,000.

On the Parliamentary Estimates the University of London also appears, nominally, as the recipient of £16,050. But what the State gives with one hand it more than takes away with the other, for it rakes into the Treasury the fees paid by candidates for examination by the university, and these amount to £17,152. So that the University of London instead of receiving State support, actually supports the State by the amount of £1,102 per annum. In addition to this the Treasury charges the university—a State institution be it remembered—with a sum of £1,901 for repairs, furniture, fuel, gas, and rates, in respect of its building, and £70 additional for auditing its accounts at the Government audit-office. These sums the university has to pay out of its slender income from provincial and school examinations. So that *it actually pays to* Government a subsidy of £3,073. These facts are not generally known. But what a commentary they furnish upon the appreciation of higher education in England! Scotland, with a population of 4,000,000 persons, is given £70,000 a year to maintain its four universities; Wales, with 1,800,000, is given £15,000; Ireland, with 4,700,000 people, receives £44,000, and has an endowed university in Dublin besides. While London, with its 5,000,000 inhabitants, not only has no teaching university at all, but has as a university a mere examining board, whose profits of £3,073 a year are seized by Government, while the sum of £1,700 a year is paid to University College, and £700 to Bedford College (Women), out of the £15,000 a year allotted to English university colleges. (King's College is also to have a small grant during the current year. The total sum paid to the above two London colleges amounts to £2,400 a year. Well may we say that this is a London question. How is it that every member of Parliament sitting for a London constituency does not demand that justice shall be done at home? London members will cheerfully vote thousands of pounds for university maintenance elsewhere, while their own university is not only crippled and tied down to perform the lowest only of all university functions, but is taxed by the State for the privilege of doing even this.

THE PROBLEM FOR LONDON.

The problem therefore presents itself—How is London to be provided with a great university? It is not a problem of which the solution has never been attempted elsewhere. On the contrary, some of the great universities are of quite recent origin. The great University of Berlin was founded in 1810. About the same time was founded the University of Bonn, made famous by association with the names of Clausius, of von Hofmann, and of the lamented Heinrich Hertz. Since the date when the existing charter of the University of London was granted—1863—several great universities have been founded, either by enlarging older and smaller bodies or by creating new ones. Since that date, the universities of Cornell, Tokio, Baltimore, and Chicago have been created. The University of Strassburg has been founded upon the nucleus of the old Faculties previously existent. The University of Paris has been re-constructed, and its old Sorbonne replaced by a new Sorbonne, around which a magnificent series of institutes, museums, and laboratories have grown up. All over France the provincial Faculties, which under Napoleon had been pinched to exalt the glories of the central University of Paris, have, since the great disasters of 1871, been reorganised on a liberal scale, and are now practically local universities. In England, the "Victoria" University has been organised as a federal university upon the basis of the three flourishing colleges at Manchester, Liverpool, and Leeds. Of all these new developments, perhaps the most striking is the case of Strassburg; since it shows what can be done when a clearly-defined purpose of creating a great university is carried out with knowledge and energy, and with the resources of a nation to ensure success. A series of "institutes" or laboratories was built for the various departments of science, at a cost of from £16,000 to £35,000 apiece, and annual sums for maintenance allotted to them, varying from £300 to £1,300 each. The total sum spent on reconstructing and equipping the University was £711,000. The Imperial Government gives a subvention of £46,000 a year. Within the year this splendid array of institutes has been enlarged by the addition of two new buildings. A new clinical hospital has been added at a cost of £22,500, and a new zoological laboratory museum at a cost of £17,300; this latter being a gift of the municipality. £5,750 a year is spent on the library—now the largest of any university on the continent—£1,600 a year on the maintenance of the museums, laboratories, and medical schools, and £26,000 on the salary of the professoriate staff. The chairs are regarded in Germany as ranking with those of Munich and Leipzig, being next in value to those in Berlin. The University can therefore secure the most eminent men as professors, and so be certain of attracting the best class of students, raising the standard both of learning and teaching, and ensuring the best possible guarantee of the permanence and reputation of the University. Thus did Germany raise an intellectual fortress to guard her frontier.

But, happily, to make a great university in London will not require such heroic measures. Money must indeed be forthcoming, as is witnessed by every creation of a great university. To maintain efficiently even a small university requires, as is evident from the Table, an income of at least £30,000 a year. To maintain a great university, having full equipment in all Faculties, needs an income of £50,000 to £100,000 a year. If we take the higher figure, we are still behind Vienna, Paris, and

Berlin; far behind Harvard; and only just beyond the figure attained by the incomes of Leipzig and of Edinburgh. However, let us take the lower figure of £50,000. Is this impossible? Surely not. Let Government, in the first place, instead of mulcting the university of £3,000 per annum, treat it as it treats the University of Edinburgh, to which the Parliamentary grant is £15,222. Then assume that the fees paid by candidates for degrees will remain as they are at £17,000—though doubtless they will increase greatly—and that the other income of the university—at present about £4,000—will remain as it is. Further, that the Technical Education Board of the London County Council will fulfil its promise to give £10,000 a year for the purpose of maintaining university laboratories and other extension of facilities of instruction. This brings the total at once to £46,000, without any of the other sources of revenue that are obviously possible.

As to the material developments that are needed, much is ready to hand in the fact that there is already in prosperous existence a great college—almost a small university in itself—to wit University College, which began its career as "the University of London." Further there is King's College, which, if it were not unfortunately maimed by the religious test imposed on its teachers, would form an admirable second college of the university. Then there are the nine medical schools, besides the two attached to the colleges, and there is a school of medicine for women, There is a school of Oriental languages, which originated with the Imperial Institute, and is at present accommodated partly in King's College, partly in University College. There is the Royal College of Science, with its mining school; there are Bedford College, and Queen's College for women. Those great professional bodies, the Royal Colleges of Physicians and Surgeons, do not teach; but they hold the powers of granting qualifications for practices. For a law faculty there already exists the Inns of Court, with the Council of Legal Education and the Incorporated Law Society; and there is a host of smaller institutions, of which some will assuredly make good a claim at no distant date to be recognised as doing part of the work of a teaching university. Out of these elements there is abundant material for the organising of a great university. London is rich above all other capitals in its libraries and its museums, some of which are in the possession of the colleges, with their wealth of collections for the student devoted to research. No city has ever presented such an opportunity for the rearing of a great university.

The Rival Schemes.

For the past twelve years, as most persons are now beginning to realise, the question has been anxiously debated as to how such a great university might be formed. There are two main courses open. One is to emancipate, enlarge, and reconstruct the present University of London, and make it into a teaching university. The other is to create a second and separate body in London, by a co-ordination of the teaching elements, outside the existing University. This proposal to found a second and separate body, under the style of the "Gresham" University, has been before the public since 1892. Choice lies between this scheme and that of reconstitution. The objections to the existence side by side of two bodies, both Universities of London, one a real teaching university, the other a mere examining Board, are too obvious to need mention. It would be an educational blunder of the first magnitude to adopt this solution of the problem so long as any other is possible. Two Royal Commissions have successively considered this subject. Each in turn has reported in favour of reconstruction, and against a rival creation. After protracted consideration, the whole of the bodies affected by reconstruction have, at last, come into line. Three schemes which successively originated in the Convocation of the University, and four which originated in the Senate, have been weighed and found wanting. The Gresham University scheme, though it passed the Privy Council, was rejected by Parliament. The only really comprehensive, far-seeing scheme of reconstitution is that of the second Royal Commission under Lord Cowper, which, appointed by Lord Salisbury in his former administration to consider the Gresham scheme, unanimously reported against it, and, instead, proposed the method of enlargement and reconstruction, together with the admirable suggestion of an impartial tribunal, in the form of a commission armed with Parliamentary powers, to adjust the various interests of the bodies to be co-ordinated in the university.

Into the petty squabbles that have arisen since the various bodies came into line, and into the alarmist manifestoes lately published. I shall not attempt to enter further than to remark on the airy ignorance and self-interest displayed by some of the persons who go about saying that if the University of London is reconstructed so as to become a teaching—that is a real—university the value of its degrees will be lowered. Experience tells a precisely opposite tale. Just in proportion as the university fulfils its higher functions as a seat of learning and research, so does the prestige of its degrees rise. It is earnestly to be hoped that the Prime Minister—a minister with the largest majority behind him that Parliament has seen in our time—will not hesitate to carry out the recommendations of his own Commission. That the scheme is not perfect in every detail every one will admit; but it has this great merit, that it itself provides a tribunal for the hearing and deciding of amendments that may be suggested; and, with the safeguard of a further appeal to the Privy Council, it ought to satisfy even those who have consistently opposed every other scheme. Maintaining unimpaired the feature of having degree examinations open to all-comers, whether collegiate or non-collegiate, whether from London or elsewhere, it incorporates all that is best in the existing teaching bodies in London, co-ordinating and strengthening them. The impulse which such an enlarged university will give, both to collegiate teaching and to non-collegiate study, cannot be overestimated. Would that the long-standing reproach that London has no true university might thus finally be removed. If—as the recent Royal Commission on Secondary Education suggested—the organisation of secondary education is to be carried out, by a reform of the Education Department and the appointment of a Minister of Education, and if, at the same time, the programmes of secondary schools in London are well co-ordinated, so as to lead from the primary schools below them to he colleges of the university, London will have no lack of students in her university; but her university will also become a centre of resort or ripe students—graduates of other universities—who will seek within its borders that still igher training which it, with its unique opporunities, will afford.

Do we not then seem to be within measurble distance of the realisation of this much-o-be-desired end? Who knows? Prejudice, ecclesiastical bias, and ignorance all rear opposing heads. Already the ignoble methods party politics, seeking to catch the support the least informed, have been resorted to to revent the calm and dispassionate discussion of the question. Common fairness has been laid aside, not once, nor twice, in the attempt to stop the wheels of progress. The person who has had little or no opportunity of acquainting himself with the facts at issue is extolled as the true and only person to pronounce an opinion. A veto over the authority of Parliament has been—in my judgment—foolishly claimed for those who will not even have heard the evidence. How is it, why is it, that when a Government has gone to the length of appointing a Royal Commission, and that Royal Commission has spent many months in elaborating its decision, that the Government fails to give executive force to its unanimous recommendations?

On this point I cannot do better than adopt the words which Matthew Arnold wrote in 1874, in the preface to the second edition of his "Higher Schools and Universities in Germany," on the very topic of the organisation of universities:—

> "A statesman having to make a law about public instruction, is not, with us, free to make it according to the best lights of his own experience and judgment; he is hampered by the likes and dislikes of the community, which are necessary to his support. And of the men in general who compose these, the judgment and experience are, by the supposition we follow, and indeed by the very nature of things, inferior to his own. Probably, at the very best, it will be a give and take between him and them; he will concede something to their prejudices, and will try, along with this concession, to slip in as much of what he judges to be really right and expedient as he can. . . . . Therefore, in any matter which, like education, touches many passions and prejudices, we do not get the best our statesmen would naturally devise; and what we do get is given in a manner, not to correct popular prejudices, but rather to humour them. Our statesmen, therefore, and their measures, do, directly, hardly anything to check and set right wide-spread errors amongst the community."

Alas, how true are these words to-day, when the statesmen who ought to be the first to recognise the educational needs of London, and to devise means for meeting them, try to stifle the reorganisation which two Royal Commissions have successively recommended. The very last thing that occurs to them to do is to take the simple course of following the advice of those whom they appointed in 1892 to take evidence and advise them. They seem to prefer the counsel of those who know not to the counsel of those who know, As one who is himself a graduate of the existing university, and who, so far as his science degree is concerned, is mainly a non-collegiate student, I should be the last to countenance any proposals to close the door against non-collegiate candidates coming from all parts of the United Kingdom. In the provinces, and in London, though outside its colleges, are scores of hardworking and needy students in whose interest the door must be kept open, and for whom, until some better way is found of meeting their educational wants, the University of London must continue to be a nursing mother. To preserve this feature—a most valuable one in the past—is the duty of every loyal London graduate. A separate Gresham University, which would be exclusively collegiate, would be disastrous to the welfare of the external students. On the other hand, whenever the existing university is reconstructed, it ought to include, as an important feature, a special standing committee or board, to take charge of the interests of non-collegiate students, including in its operations both those in London and those in the provinces. One scheme only, out of the score put forward during the past twelve years, possesses this feature—the scheme of the Cowper Royal Commission.

Consider, finally, how radically different is that ideal of education which inspires the creation and maintenance of great universities, from the narrow and *doctrinaire* view which makes examinations the final good toward which all else is subordinated, and the winning of a degree the sole end and object of university existence. A degree is but a step (*gradus*), yet a step that leads to something higher; and, in the true university, a student's intellectual life begins when he ceases to work for a mere degree, and pursues learning for its own sake. The student who, to use Lowell's phrase, makes literature a ladder to a language, instead of making language a ladder to literature, becomes a pedant, not a scholar, and wherever the examination is made, the end, not the subordinate incident, in a university course, the inevitable result is the substitution of pedantry for scholarship, of cram for training, of the second-hand or tenth-hand information of the text-book for the first-hand learning which it is the aim of a true university to afford. Think of all that is implied in the following single fact. In the regulations of the University of London for the degree of Bachelor of Science, not a line has been changed since 1876 in the syllabus of subjects for the written examinations (and there are no *viva voce* examinations) in such progressive sciences as chemistry and physics. It is no use—in effect says the University of London to its would-be Bachelors of Science, and to the teachers under whom they study—to know anything about the discoveries or developments of the last twenty years ! No questions can be asked in chemistry about argon or helium, or even about so fundamental a topic as the periodic law. No questions can be asked in physics about the microphone or the phonograph, about alternate currents, or about Hertz's classical researches on electric waves. What you do not find in the text-books of twenty years ago is not science. Here you have examinations not making for progress but acting as a positive drag on the wheels of knowledge, degrading and cramping the science teaching and the private study of science, not in London only but all over England. What wonder that Manchester revolted against the domination of the University of London. What wonder that the three Welsh colleges demanded, and obtained, their own university. What wonder that the colleges in Birmingham, Nottingham, and Bristol cry out for a Midland university. (And rightly too, for they will assuredly deserve to have it at their present rate of sturdy development.) What marvel if the London colleges—the worst sufferers from the want of a true university — are banded together to bring about a healthier state of things. So long as the antiquated syllabuses control the teaching, so long as education is sacrificed to outside examination, intellectual progress suffers. We throw away the kernel in our eagerness to preserve the husk. Our students work for degrees which are supposed to be the hall-mark of culture ; but they do not attain the culture, because they aim only to win its hall-mark. And the university, whose proper aim is to promote the culture, busies itself only about the hall-mark, forgetting in its anxiety about the hall-mark, that culture and its hall-mark are not identical.

Our protest against this false ideal is the one dominant note in this ten-years' struggle for reform in the university. The worship of this false ideal is the only thing that stands in the way of the making in our midst of a great university worthy of the age in which we live, and the city and country in which we dwell.

DISCUSSION.

Dr. Reich said he had had a pretty wide experience both of the Continental and British methods of education and examination. He described in some detail the system in vogue at Continental universities of professors, extraordinary professors, and privat-docents, and expressed a very strong conviction that professors, however eminent, who were not actually engaged in teaching, were not fitted to conduct examinations. He was also strongly in favour of *viva voce* examinations rather than written, as being the only way in which really trustworthy results could be obtained.

Mr. H. Macan, whilst agreeing with every word in the paper as to the necessity for creating a teaching university for London, advocated the extension of the scope of the university for the administrative County of London, so that it might include greater London, and embrace the home counties of Surrey, Kent, Essex, and Middlesex. Why should a student from Wimbledon be placed at a disadvantage compared to one from Wandsworth, or one from Bromley be treated differently to one from Greenwich? There were no large centres in these counties where a university could be established; they all looked to London as their centre, and such colleges as the Holloway College at Egham, and the South-Eastern Agricultural College at Wye, should stand on an equal footing with other colleges in the county of London, which it was proposed to include in the machinery of the re-constructed London University. It appeared from the report of the Royal Commission that both these establishments were equal in every respect in the character of the students, in the work they did, and in the position of the professors, to some of the colleges which it was proposed to include. He might further point out as showing the inconsistency of the scheme, that it included two colleges which were not in the administrative county, viz., the Wesleyan College at Richmond, and the Congregational College at Cheshunt. Then, again, the University Extension work—with which he was in entire sympathy—was to have certain privileges conferred upon it, but this work was to a great extent carried on in districts outside the administrative county; whilst such colleges as those to which he had referred were to be excluded. But perhaps the most extraordinary proposal of all under this scheme was that the university should contain a faculty of agriculture, which it was hoped would receive aid from the Royal Agricultural Society, which was to nominate a member of the senate, and the work was to be carried on, not at Wye, where there were laboratories and every appliance for teaching agriculture, but in the physic garden at Chelsea. He contended that the proposal to exclude the home counties from the benefits conferred on internal students was entirely contrary to the spirit in which the new university was proposed. The Victoria University did not limit itself to the counties of Lancashire and Yorkshire, and the proposed Midland University would include all neighbouring counties, and why should the London University be confined to the county of London? According to the report of the Royal Commission on Secondary Education, the colleges in the home counties could claim a voice in nominating the governing bodies to be established in those counties for the purpose of secondary education, and they might equally claim to have an interest in the new university of London. He hoped Professor Thompson would see his way to accept this suggestion, for if not, he feared a strong opposition to this scheme would be aroused.

Mr. J. S. Thornton said he remembered Lord James when Sir Henry James once saying that it was a cardinal point with a good advocate not to overstate, but rather to understate his case; and in one point he thought Professor Thompson had broken this rule. When he referred to the very small amount spent by the London University on its library, &c., he ought to have taken into account the libraries, laboratories, and museums of University College, King's College, the School of Mines, &c., because, when the new university was established, all these would be connected with it, and would form an integral portion of the machinery available for carrying on the work of the university.

Prof. H. E. Armstrong F.R.S., feared the discussion, as often happened, had rather strayed from the main point, and perhaps Professor Thompson was partly answerable for it, because he (Dr. Armstrong) thought a great part of his paper was entirely unnecessary at the present day. They did not want to be told what other people were doing. What they had to do was to make up their minds what they were going to do themselves. The question was, did they want a university in London, and if so, what kind of a university? It had been settled for a long time that they wanted one, but as to the kind, it was obvious that opinions were divided in a most extraordinary way. As was said in the paper, the larger issues had been obscured, and the majority of the people who discussed the matter did not know what they were. What they had to do at present was to take careful note of the present political situation. What he wanted to see was a system of education introduced into this country which should make it unnecessary to buy articles made in Germany because they could not be procured or made at home. He had had considerable experience of what was going on in Germany, and had the greatest respect for the educational work that great nation had performed, and however little inclined they might feel inclined to take advice from Germany, she stood before the world as the only country which had shown a true appreciation of education. We needed to put ourselves in such a position that all our manufacturers and people should understand why the German nation had been so extraordinarily successful in manufacturing and industrial enterprise generally. If that were done the people would insist on a university being established in London, where teaching should be carried on in the best possible manner, so that men and women should know the true meaning and value of education, and should learn to march with the times, and do their work in the world to the best possible advantage. The present London University, however, was not quite so bad as had been represented, and the remarks upon the syllabus with reference to physics and chemistry were hardly worthy of Professor Thompson. Although the syllabus had been in existence for twenty years it did not prevent the examiners putting questions in accordance with the knowledge of the times. He (Dr. Armstrong) had been an examiner for the last few years, and he had found no difficulty in the matter. The present system represented the English ideal of education, and what was wanted was to change that ideal. It was not a question of London only. The examinations of the Victoria University were practically the same as those in London, but there was an organisation of the teaching institutions in Manchester, of the Yorkshire colleges, and the Liverpool colleges, and together they formed a university, whereas in London, though there were a number of very valuable educational institutions, there was no organisation amongst them, and, consequently, the University of London was not in accordance with the teaching going on in those colleges, and, therefore, the colleges did not send up their students. The great need at present was the formation of a true ideal of what constituted education in these days. It was practically founded entirely on a knowledge of the past, following the literary ideal laid down in generations gone by. We had altogether altered our mode of working in many things, but in education we still adhered to the old methods.

Sir **PHILIP MAGNUS** thought some of the speakers had not fully grasped the importance of the question raised in the paper, but had gone off on side issues, which had very little to do with the question of making a great university for London. He thought the statistics quoted were very pertinent, showing, as had never been shown so fully before, what was being done in other countries; and he could not but think that when these statistics were brought to the attention of those in authority, they would see the importance of doing something to improve the university education in the metropolis, if only to prevent the occurrence of those obnoxious words—"made in Germany." Mr. Macan had also gone off on a side issue, for his appeal might very well have been brought before the Statutory Commission, or the Privy Council, or any other body which had to revise the scheme of the Royal Commissioners, and it was scarcely necessary to emphasize the claims of those two small but, no doubt, important colleges with such vehemence. They were face to face with a very important question. For many years London had been crying out for some kind of organised university, and the very fact that some ten or twelve schemes had been put forth, showed that the question was a burning one, and one which they hoped might soon be finally settled. It was a scandal to the inhabitants of the metropolis that they alone should be lacking anything which could really be called a local university. It seemed to him that they had now come to the parting of the ways, and that they must decide whether they were to have one university in London, or two. It was quite certain they could no longer be content to go on with the existing London University in its unreformed condition, and he agreed with those who thought it better to reconstruct the present one than establish another. If the latter course were followed, they would have a metropolitan university which would be worthy of its name; all the various educational bodies now existing in London would be focussed in one central university, and the libraries and museums now existing would be associated with it. It would be, in every sense of the word, a university which would gather to itself all the best teachers, and would represent all the highest ideals of education. But, side by side with that, they would have the present university bearing the name of the London University, but nothing more, and becoming absolutely disassociated from all the teaching institutions of London; and condemned for ever and ever to be nothing more than an examining body similar to the Civil Service Commission. All its prestige would be gone, it would have a chancellor, but he would occupy no position of dignity; it might have a senate, but no one would be proud to belong to it; it might have members of convocation, who would go on discussing questions as they had done in the past, but no one would pay any attention. At present it was one of the privileges of the London University to nominate its own members on the governing bodies of other institutions, but that privilege would be taken away, because the Secondary Education Committee had apportioned one representative to the University of London, or two, provided it became a teaching university, and every other institution would naturally give its representation to the university which deserved the name, and not to a mere examining commission. On the other hand, with a reconstructed university they would be organising the teaching institutions of London, and he feared the importance of this point had not been sufficiently insisted on in the many discussions which had taken place. They preferred to have one large central laboratory, to which should be attached professors of various specialised branches, and dealing with the highest developments of that subject, rathe than three or four laboratories scattered about, all o which were teaching more elementary subjects These institutions would be united, and there would be divisions of labour amongst the professors, a well as co-ordination of teaching facilities. This could only come about under some such scheme as Professor Thompson had sketched out. Unfortunately, there were opponents, but he was glad to think that the objections raised had been reduced to very small dimensions; and as all the important educational bodies had fallen into line, he hoped that, by consultation and discussion, and perhaps a little compromise, all differences might be removed. It would be better to sacrifice a little than lose the scheme altogether. Hitherto too much importance had, undoubtedly, been attached to the mere attainment of a degree. It might mean something, but it did not mean all that those who attached so much importaace to it believed. It was of the greatest importance that collegiate study should be recognised and encouraged; but it did not seem to him that the new scheme would place the outside students in any worse position than they were in at present, but rather the contrary; and it therefore seemed a very dog-in-the-manger kind of policy to object, on their behalf, to any encouragement being given to collegiate study, which was always recognised as being of great importance.

Mr. M. CRACKANTHORPE, Q.C., said he entirely agreed with the paper which had been read, and considered the statistics attached to it extremely valuable. As far as he knew, they were brought together for the first time, and they brought into striking contrast the sterilised condition of the metropolis as compared with all the great, and many of the small, cities of Europe and the United States. Not long ago, when in Italy, he read a tabular statement of the war ships of the different countries of Europe, which was published in an English paper to show our predominance in naval matters. Professor Thompson had exactly inverted the position, and had shown the absolute superiority of other countries in university culture. Allusion had been made to a certain obnoxious phrase, and that was exactly what he complained of as an Englishman and a university man. If he wanted the best authority on the English Poor-law, if he desired to examine into the history and development of workmen's associations and friendly societies, or if, as an owner of land, he wanted to know a little of the history of how his forefathers divided property and to get some good idea of the tribal system in early times, in each case he had to go to a foreign writer to get anything like trustworthy information. If a struggle were imminent in Europe, or South America, or Africa, which involved international questions, he was quite certain there was not a single English writer who would not be surpassed by a foreigner in the information he could give. Dr. Armstrong said we did not want to know what others were doing, but what we ourselves were doing or not doing. In the department of law he happened to know what we were not doing, and it illustrated the dearth which now existed. He did not wish to say a word in depreciation of the Council of Legal Education, of which he had the honour to be a member, but if a question of great historical or international interest were to arise, and it were desired to get the best information on the subject, there was no machinery at the command of the Council of Legal Education, or any of its professors, which would be able to satisfy that want. He was equally confident that in the universities enumerated by Professor Thompson, particularly in the Johns Hopkins University at Baltimore, those subjects were thoroughly studied. Both as a member of that Council and as a student of law, he felt the dearth under which we suffered for want of systematised university teaching. He felt confident that ignorance was the great barrier to reform. People did not understand the disadvantage at which they were placed, and for that reason there was so little enthusiasm. He hoped that meetings like that would give an impetus to the movement initiated by the Commission. They all admitted that there might be defects in the scheme, but they were remediable by appeal to the Statutory Commission, which was recommended, and he trusted that the Commission would see the fruit of its long and arduous labours before many years had passed, in the establishment within the metropolis of a university worthy of the name.

The CHAIRMAN, in proposing a vote of thanks to Professor Thompson, said his paper was very opportune, and the statistics which it included could not be too much impressed on the public mind, as an indictment against the country for leaving waste resources unparalleled in the civilised world. He was quite convinced that, if there were in any other country the treasures we had in London, both in the way of museums and libraries, and of men who were prepared to teach, it would not take ten, twelve, or twenty years, to bring about the result required, but that whoever was the director of public instruction in that county would at once say to the minister, that it was his duty to lay on the table of the legislature a Bill for the establishment of a teaching university. Among the many extraordinary symptoms which this controversy had brought to the surface there was one of a very curious nature. Whenever they read an argument against the creation of such a university they found either outspoken or in a latent form this accusation, "Such a scheme will hand us over to the tender mercies of the London teachers." Now to the tender mercies of the teachers higher education was left in all the countries of Europe. He was not yet acquainted with the constitution of the university of Tokio, but he should be much surprised if they found there the slightest jealousy of leaving to the teachers the management of that which they must understand better than others. As a member of the Cowper Commission he had been agreeably surprised to find that amongst all those on whose opinion the Commission set most store, there had been hardly a dissentient voice. In the case of every former report or scheme, those who would have had to put it in operation, and on whose labours its success depended, were in doubt, not about details, but about some leading feature; but this last scheme had been accepted not only by the teachers in London, but by the staffs of those very provincial sshools whose students, they were told, in some questions had not been sufficiently considered. The best answer to the difficulty about external students was that given by Professor Thompson when he said that learning, not teaching or examining, was the primary essential. That meant that, in a teaching university, the individuality of the teacher should be allowed its full scope, and also that each individual student should be allowed to work for the sake of learning, not for the sake of the examination. There might be as much difference between two internal students as between an internal student and an external, and in the examination the individual character of each student would be allowed for. The external students would not only have the same guarantees of a fair examination as at present, but perhaps even better; but if further guarantees were wanted, by all means let them be given. The great point was that internal students of London should, at least, have that to which which they had a right, a teaching university of their own. It was nothing less than a scandal that London, with a greater population than Scotland, or than many of the countries of Europe, which had two or three universities, should not have a university of its own. With regard to the question of the boundary line every one who had had any experience in such questions knew that controversy was endless, but that was a matter for the statutory commission, and the subjects to be included in the curriculum were also open; but agriculture was expressly included, because it was found that at most universities the science of agriculture, apart from its practical aspect, was deemed essential. He thought it was not only the duty, but the privilege of any Government of this country to at least give to the metropolis and to the empire, a worthy university.

The vote of thanks having been passed unanimously,

Professor THOMPSON, in reply, said he thought Mr. Macan had misread the paragraph in the report referring to the physic garden at Chelsea. As he understood, it suggested that it might be made available for experimental purposes in connection with the study of chemistry, as applied to the physiology of plants. He thought the fact that the Cheshunt and Richmond Colleges were included was sufficient evidence that the Commissioners did not mean to draw a hard and fast lines, but used the words "administrative county of London" in a descriptive kind of way; but this was just one of the points which would be best settled by the Commissioners who had to draft the final statute. He had referred to the existing museums and libraries which Mr. Thornton had mentioned. With regard to the syllabus, Dr. Armstrong spoke of his experience, but he was a strong man who had dared to do what a weaker examiner would not, and had gone outside the syllabus; but he must know that there had been complaints, not only from candidates, but especially from the crammers who prepared them, about questions being put which were not within the four corners of the published syllabus. With regard to the necessity of going to German resources, he might point out that he could not possibly have got together the statistics he had included in the paper, if he had not had at his command something made in Germany, viz., the book "Minerva," which was a kind of intellectual Baedeker, in which the intellectual development, not of Germany only, but of the whole world, was registered, so far as it expressed itself in universities and schools of all kinds above the primary grade, and in libraries, museums, and collections of all kinds.

Miscellaneous.

BARCELONA EXHIBITION, 1896.

It has been arranged that the third general Exhibition of the Industrial and Fine Arts shall be held at Barcelona in the present year, and open on the 23rd of April. In the Section of Fine Arts there will be three groups:—

I. Painting, Design, and Engraving.
II. Sculpture.
III. Architecture.

The Industrial Arts will be divided into four groups, viz.:—

I. Jewelry and all kinds of Art Objects in Metals.
II. Pottery and Glass.
III. Joinery and Cabinetmaking in their artistic application.
IV. Tapestry, Tissues, Laces, Embroidery, &c.

General Notes.

COMMERCIAL MUSEUM IN NEW YORK.—According to a New York engineering journal, a movement is on foot to establish in that city a permanent commercial museum. A company has been organised under the name of the International Permanent Exposition Company, including in its Board of Directors a number of well-known merchants. The company will not undertake to do any selling or commission business, but the intention is to secure specimens of the production of different countries, with a library of information as to the industry, climate, and soil of the various countries, the habits of the people, and particulars as to currency, weights, measures, &c. Technical works on the industries of the world, technical dictionaries and similar works will also be collected and kept in the library with official returns, reports of foreign countries, and similar matter. A bureau of information is also to be established, which will collect and compile information with regard to the foreign commerce of the United States, and give such aid as it can to the development of trade with other countries. Arrangements will also be made to collect detailed information concerning commercial opportunities and the demand for certified products in given localities. It is stated that already a large number of firms in different parts of the country have promised their assistance and co-operation.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

JANUARY 22.—"Supply of Sea-water to London." By FRANK W. GRIERSON.

JANUARY 29.—"Standards of Light." By W. J. DIBDIN, F.C.S. CAPTAIN W. DE W. ABNEY, C.B., F.R.S., will preside.

FEBRUARY 5.—"The Mexican Drainage Canal." By FREDERICK HENRY CHEESEWRIGHT, M.Inst.C.E.

Papers for evenings, the dates of which are not yet fixed :—

"Dairy Produce." By GEORGE BARHAM.

"Some Native Irish Industries." By PROF. HADDON.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Musical Pitch." By A. J. HIPKINS.

"Report of the Royal Commission on Secondary Education." By H. MACAN.

"Water Purification by means of Iron." By F. A. ANDERSON.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock :—

FEBRUARY 13, at 4.30.—"Punjab Irrigation—Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab. LIEUT.-GENERAL R. STRACHEY, R.E., C.S.I., F.R.S., will preside.

FEBRUARY 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. TRIPP, formerly of Sumatra.

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E.

APRIL 23, at 4.30.—"The Deserted City of Hampi." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

FEBRUARY 4.—"The Garden in Relation to the House." By F. INIGO THOMAS.

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S.

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

JANUARY 28.—"Stamboul: Old and New." By RICHARD DAVEY.

FEBRUARY 18.—"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL (General Electric Company, U.S.A.).

MARCH 17.—

APRIL 21.—"Madagascar." By CAPTAIN PASFIELD OLIVER.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.

JANUARY 20.—LECTURE I.—*The Action of the Transformer.*—Real and imaginary transformers—Transformer diagrams—Alternate current curve tracing—Various forms of curve tracers—Discussion of transformer diagrams—The harmonic analysis of diagrams—The curves of induction and hysteresis—Magnetic leakage—Core and copper losses—Effect of variation of form of the electromotive force curve on core losses—Variation of core losses with temperature—The power factor.

JANUARY 27.—LECTURE II.—*The Construction of the Transformer.*—The core—Sheet-iron stampings—Building the core—Prevention of core losses—Selection of iron—The coils—Coil winding—Insulation of coils and core—The case—Ventilation and surface radiation — The terminals — Primary and secondary fuses and switches—Sizes and forms of transformers in practice—Open and closed circuit transformers.

FEBRUARY 3.—LECTURE III.—*The Testing of Transformers.*—The measurement of the power taken up in an inductive circuit—The theory of the wattmeter—The construction and use of the alternate current wattmeter—Various methods of measuring alternating current power—The testing of transformers—Testing by curve tracing—Testing by the wattmeter—Differential testing—Practical tests in the sub-station and workshop efficiency curves—Core losses for various sized transformers—Specifications for transformers—Measurement of copper losses and drop—Iron testing.

FEBRUARY 10.—LECTURE IV.—*The Employment of the Transformer.*—Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs or alternating current stations—Conclusion.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.
February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.
March 9, 16, 23.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. A. Fleming. "Alternate Current Transformers." (Lecture I.)

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Capt. Abney, "Exposure and Development."

Surveyors, 12, Great George-street, S.W., 8 p.m. Col. G. W. Raikes, "The Re-apportionment of Rates and Taxes."

British Architects, 9 Conduit-street, W., 8 p.m. 1. "An Address to Students," by the Chairman. 2. "Observations on the Students' Work," by the Art Standing Committee. 3. The Presentation of Prizes.

Victoria Institute, 8 Adelphi-terrace, W.C., 4½ p.m. Mr. Pinches, "Newly Deciphered Inscriptions."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. J. C. Morton, "Cambridge University: its History and Development."

TUESDAY, JAN. 21...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Coverings of Plants and Animals: its Structure and Functions." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on The Hon. R. C. Parsons's Paper, "The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water-Supply."

Statistical, Royal United Service Institution, Whitehall, S.W., 5 p.m. Mr. J. A. Baines, "Parliamentary Representation in England, Illustrated by the Elections of 1892 and 1895."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. E. Sanger Shepherd, "Irregular Grained Screens."

Anthropological, 3, Hanover-square, W., 8½ p.m.

East India Association, 3, Victoria-street, S.W., 2½ p.m. Mr. Alexander Rogers, "A Historical and General Sketch of the Province of Guzerat,"

WEDNESDAY, JAN. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Frank W. Grierson, "Supply of Sea Water to London."

Geological, Burlington-house, W., 8 p.m.

Photographic Club, Anderton's Hotel, Fleet-street, E.C. 1. Mr. Harold Baker, "The Avon Valley." 2. "Tests with Lime Light Jets."

Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. "Demonstration of the Photo-Autocopyist."

THURSDAY, JAN. 23...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. Prof. G. F. Fitzgerald, Helmholtz Memorial Lecture.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. W. W. Howell, "Unexplored Glaciers of Vatna Jökul."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Philip H. Wickstead, "Dante." (Lecture II.)

United Service Institute Whitehall, S.W., 3 p.m., Captain Kenney Herbert, "The Best Method of Teaching Military Sketching."

Camera Club, Charing-cross-road, W.C., 8 p.m Major Lysaght and Mr. Davis, Exhibition of Lantern Slides.

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. R. W. Rew, "Co-operation as Applied to Agriculture."

FRIDAY, JAN. 24...Royal Institution, Albemarle-street, W., 8 p.m. (Weekly Meeting, 9 p.m.) Prof. Burdon Sanderson, "Ludwig and Vitalism."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. E. Scott and Signor Monticolo, "Exhibition of some Geometrical Instruments." 2. Mr. J. D. Everett, "Resultant Tones." 3. Sir D. Salomons, "Experiments with Incandescent Lamps."

SATURDAY, JAN. 25...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. R. Lawrence, "The Valley of Kashmir."

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FRIDAY, JANUARY 24, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Dr. J. A. Fleming, F.R.S., delivered the first lecture of his course on "Alternate Current Transformers," on Monday evening, 20th inst., the special subject being "The Action of the Transformer."

The lectures will be published in the *Journal* during the summer recess.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 16: The Right Hon. George N. Curzon, M.P., in the chair.

The Chairman, in opening the proceedings, said that Colonel Woodthorpe was a man of almost unique experience on both sides of India—one of the class of men who were doing work of the highest importance in the service of the State, of which the world knew very little. From time to time they came to such meetings as that, and gave an account of what they had done, and communicated some of the knowledge of which they were the sole possessors, and then modestly retired to their camp or their desk to continue their labours. His own acquaintance with Colonel Woodthorpe began ten years ago, when he was a member of the Commission which, under Sir William Lockhart, went up to Hunza, explored the Southern Pamirs and the Oxus valley, and going on to Chitral, first established friendly relations with Aman-ul-Mulk. He was afterwards at the head of the Indian Intelligence Department at Simla, and was subsequently transferred to the North-Eastern Frontier, where he was in charge of the survey operations on the Commission then delimiting the boundary between the States we had taken over from Burma and Siam. It was only natural, therefore, when, a little later, another Commission was sent out under Mr. J. G. Scott, to inquire into the geographical character of the region out of which it was proposed to constitute a buffer State, that Colonel Woodthorpe should be a member of it. It was on these two expeditions that he obtained that acquaintance with the Shan country and people, some of the results of which he was about to narrate. In addition to this, he was an admirable artist, and some of the sketches he had made would be placed upon the screen.

The paper read was—

THE SHAN HILLS: THEIR PEOPLES AND PRODUCTS.

By Col. R. G. Woodthorpe, C.B., R.E.,
Indian Survey Department.

The Shan States under British protection form the easternmost portion of our Burmese possessions, and may be said to lie approximately between the 19th and 24th parallels of latitude and the 96th and 102nd of longitude. They do not, however, by any means cover the whole of the area included between these parallels, but presenting a broad base towards the Irawadi, narrow down considerably towards the east, forming a rough triangle. To the west lie the great plains of Burma proper, traversed by the Irawadi. To the north and east we have the province of Yunan, with the Chinese Shan districts of Möng Lem and Keng Hung immediately on our borders. To the south is Siam.

Dr. Cushing, a missionary and a great Shan scholar, visited these States while under the Burmese rule. He tells us that under this rule peace and quiet were seldom their lot. "Divide and govern" was the maxim which guided the policy of the Burman sovereigns towards their Shan dependencies. The sons of Sawbwas were sent to the Court of Ava, partly as hostages for their fathers' good behaviour, partly to be trained in the way that they should go, the Burmese way, when they succeeded their fathers. The Burmese Government often fostered feuds which broke out between Sawbwas, and left rival princes of one family to settle their claims to the control of a principality with the tacit understanding that the victorious claimant would probably be comfirmed as Sawbwa by royal appointment. Intestine troubles were frequently fomented by Burman intrigue when a prince seemed likely to become too prosperous for the safety of Burman authority. Bands composed of desperate characters were ever ready to avail themselves of the opportunity afforded by disturbances in any principality, which invariably suffered from their visitations, the result being that the people emigrated to some neighbouring State enjoying peace. Rebellions against the royal authority were always sooner or later ruthlessly suppressed, towns and villages being burned, and the country devastated. Dr. Cushing adds that the absence of permanent peace seriously affected the prosperity and wealth of the country. The Shan States lying east of the Salween were, however, less subject to Burmese oppression than those to the west of that river.

It will be unnecessary in this brief paper to enumerate the Shan States; suffice it to say that Keng Tung, embracing most of the country lying between the Salween and the Mekong is, from its size, population, and geographical position—as the frontier State—the most important. Its chief is, moreover, connected by family ties with all the other important Shan States. Several years before our annexation of Upper Burma, the Cis-Salween Shan States had revolted, apparently against Thibaw individually, and his oppressive government, rather than against the principle of Burmese suzerainty; and shortly before our operations commenced, the Burmese troops had expelled most of the Sawbwas, and driven them to seek refuge in Keng Tung, then governed by the father of the present chief, a capable ruler of great influence, who had lately executed the Burmese political officer resident at his court, with his followers, on the ground of their excessive exactions and tyranny, and was eager to form a Shan confederacy against Burma. He assisted the Sawbwas to recover their States, and the history of the next few years is one of continual struggles between the various Sawbwas to retain possession of their own States, or to extend their borders at the expense of their neighbours. Several pretenders also appeared on the scene to increase the confusion and disorder, and the Siamese officials at Chiengmai took advantage of the disturbed state of affairs to extend their authority over some of the minor Shan States and Trans-Salween Karenni, seizing, in the latter, elephants and timber, and marking the inhabitants with an elephant and a running number. As a sad instance of the ruin and depopulation of a prosperous State, caused by this disorder, let me give you the following powerful, but sombre picture, painted by Mr. Scott, after his visit to Legya, in the Western Shan States, in 1888.

"The country is a wide billowy plain, all of which has been obviously, at no very remote date, under cultivation. The population must have been very numerous, for the land had evidently been tilled even up to the tops of the undulations. But now it was fast relapsing into simple prairie; not a single traveller was met on the road, and the eye roaming over miles and miles of country that had once been all dry cultivation, but was now rapidly being overgrown with coarse grass and scrub jungle, failed to see a living creature. Even the columns of smoke, elsewhere so universal at this time of year, where the farmer is clearing his land for the crop of hill rice, were wanting. The face of the land was as deserted and desolate as an American pampas or a Russian steppe. We marched along the main north road which had clearly been not long since a wide thoroughfare travelled over by many men and many cattle. Now it was narrowed to a mere path, which encroaching bushes and rank grass threatened at no great distance of time to obliterate altogether. Marks of tigers were seen here and there. Small streams that formerly had served to irrigate acres of fine paddy land now strayed across the path, broke through the channels which once had served to fertilise the soil, and created swamps where there should have been wide expanses of waving grain. Village sites had become mere tangles of impenetrable jungle, and in a country where a few years ago there had been vast herds of cattle, the deer barked nightly round our camp, and wild peafowl perched on the fences of the deserted cattle pens. The frontier village of On Hon was reduced to three houses; all around stretched thousands of acres of magnificent wet bottom, now a mere noisome swamp of elephant grass. The town itself has not escaped. Fifty years ago it was one of the finest and wealthiest capitals in the Shan States; but its fall has been gradual. Civil wars and local disturbances have ruined it slowly but surely. Twenty years ago it numbered only two hundred houses, but these have now dwindled to twenty wattled huts. The broad main road down which a couple of four-in-hand drags might have been driven abreast has, by the encroachment of bush vegetation, dwindled to a mere tortuous footpath. South of the town there are many splendid monasteries and elaborate pagodas. These are now deserted. The roofs are falling in, and the timber is steadily disappearing to furnish firewood to those who have anything to cook. The shrines are mouldy and deserted without a single pious offering; the jungle comes up to their very feet, and creepers tear the bricks asunder. The Haw (palace of the Sawbwa) was at one time next to Moné, the finest in the States. Nothing now remains of it but melancholy rows of blackened stumps. The chief lives in an ordinary bamboo hut. The brick wall which surrounded it is crumbling to a shapeless mound, and the former wooden gateways are replaced by petty bamboo wickets. The hanging gardens, which were at one time the pride of the State, are now a dismal growth of rank weeds. Nevertheless Legya's restoration to wealth is a certainty. Round about the capital lies a stretch of land which would afford occupation and abundant crops to 10,000 farmers. One of the lakes which formerly existed near the town has dried up, but the canal which was constructed in earlier days of wealth and energy was so well built that the lapse of time and neglect in the years of fighting have not appreciably impaired it. The supply of water is abundant and amply sufficient for the huge expense of paddy bottom. When our column was in Legya in January, 1888, rice was more valuable than silver. Want of seed grain seemed likely to prolong the miseries of the State, but the generosity of the Sawbwa of Möng Pawn, one of the most impulsive and openhanded of men, furnished the Sawbwa with one hundred bullock loads.''

For two years after our occupation of Mandalay we had our hands too full in putting down dacoity and rebellion in the plains of Burma to turn our attention to the Shan States, but gradually, and with but little bloodshed, order was restored in the Cis-Salween districts, the Sawbwas submitted to the British Government, and their submission was genuine. Trans-Salween Karenni was recovered from the Siamese, and, with the assistance of the influential and loyal Sawbwa of Moné, Keng Tung was peaceably brought under our rule, and I am happy to say that the state of things described above, visible in other parts of the States, as well as in Legya, will soon be relegated to the past, and that the hopeful anticipations of Mr. Scott are in a fair way to be realised in the near future. At first, only one Superintendent was appointed to the Shan States, but as our influence was extended, this was found too large a charge for one man, and the States were divided into the Northern and Southern Shan States, and each placed under a Superintendent with several assistants, who exercised general supervision and control. Except for the peace and general security now enjoyed, things have not altered very much. As before, each State is ruled by its own hereditary chief, who has the power of life and death, and absolute authority in his own State, so long as his rule is in accordance with the principles of justice and benevolence, and free from the oppression and cruel practices of former times. Certain sources of revenue are reserved by the Government; the rest of the revenue is a lump sum levied on each State as tribute. To the devoted labours of our political officers, Messrs. Hildebrand, Scott, and Captain Daly, and their able assistants, to their resourcefulness in emergencies, and their infinite tact and skill in dealing with both rulers and people, the Shan States owe their present peaceful and happy condition, and their increasing prosperity.

These States present a remarkable variety of natural features. The country to the west of the Salween is a series of elevated plateaux—great rolling grassy downs separated by deep valleys and intersected by lofty parallel ranges, the general direction of which is north and south. These ranges, in contrast to the yellow downs, are beautifully wooded, and attain to great heights, some of the peaks rising to nearly 9,000 feet above sea level. Along the valleys flow swift rivers, now through dark and narrow gorges, pent between mighty cliffs, now through an alluvial hollow with terraced rice fields, among which they wind with many a curve. To the east of the Salween the country is much broken up, no clearly defined range of mountains presents itself, but the eye wanders over a confused sea of forest-clad hills and narrow valleys, relieved here and there only by small plains till Keng Tung is reached. But, perhaps, if I ask you to accompany me on a hurried march from the railway at Thazi—the station whence starts the cart road to Taunggyi — to Keng Tung, a distance of 360 miles a better idea of the country and its general features will be obtained. From the train you will have seen the long line of hills lying parallel to the railway, and distant some 16 miles, inviting you to explore them. The road runs due east across paddy plains, past prosperous villages, with their monasteries and clustering pagodas, to the foot of the hills, where it enters the forest and, rising gradually, crosses a low watershed to Pinyaung, 22 miles from Thazi: here there is a village, and some good small game shooting may be obtained. Leaving Pinyaung, we pass on through a magnificent gorge, its precipitous, dark rocks giving way as we emerge from it to more inviting and gentler landscape. Tall trees rise above us, a swift, but shallow stream babbles over the stones on our left; here and there little patches of rice cultivation appear on either bank, and, occasionally, the laughter of children, the crowing of cocks, and light smoke curling up to the sunlight, attract our attention to a small village, half hidden in the jungle. Then, onwards and upwards, by many turnings and zigzags, till we find ourselves at the village of Kalaw, at an elevation of 4,300 feet: this is a beautiful little sheltered spot, its smiling fields nestling among the wooded hills, crowned with white pagodas, to which long flights of bricked steps lead up. By the roadside, guarding the entrance to one of these flights, stand two huge dragons, giving us an excellent idea of their construction; for they have only been modelled in brick, and, whether from failing funds or the death of the pious builder, they still lack—and will for ever lack—that coating of plaster and cement, which should give them the appearance of finished stone work. A tinkling of bells, and the shouts of drivers of recalcitrant bullocks warn us of the approach of a trading party; and, as we turn a corner, we come face to face with a long string of bullocks, bearing great loads of the leaf used in Burma, for cigar wrappers, which is extensively grown in parts of the Southern Shan States. From Kalaw to Hého the road runs over open, undulating ground, stretching far away to the north. In the dips lie unpleasant swamps, which presented great difficulties to the rider, before the cart road bridged them. Low wooded hills pagoda-covered knolls, and bamboo clumps, half concealing a village, or a monastery, vary the scenery. From the hills above Hého, we look over the valley of the Balu Chaung, and the view is a fine one. We stand at a height of 5,000 feet above the sea, on the edge of a plateau, whence the ground falls steeply 2,000 feet to the broad valley below. To the north and south, wooded peaks stretch away into the distance. To the east rises a parallel wall of forest-clad slopes, ending in a broken outline of hills, the huge mass of Myn Mati and the pagoda-topped cliffs above the civil station of Taunggyi standing out most conspicuously. The Balu Chaung rises to the north, and, flowing at first through forest, loses itself in a huge swamp merging into the Inlé lake, a vast expanse of water 13 miles long and about 4 miles wide at its upper end, but narrowing towards the south. It is nowhere very deep, and the bottom is overgrown with long and tangled weeds, which rise nearly to the surface. The lake dwellings of the Inthas, an amphibious tribe said to have been originally brought as slaves from the province of Tavoy, rise on piles out of the water in groups near the edge, and floating gardens, on which are grown tomatoes, water melons, gourds, and the pan leaf vine, dot the surface of the lake around them. Many large villages are seen on either shore, monasteries and pagodas, built on the extremities of the spurs, running into the lake, are reflected in its placid depths, and on the eastern shore, lying back from the water on some rising ground, can be descried the houses and barracks of Fort Stedman. Far away to the south lie the blue hills of the Karenni and Bré country.

We may now proceed direct by cart-road to Taunggyi, or descending by a steep Shan path to the lake, cross it to Fort Stedman, whence another hill track leads to Taunggyi. The lake is worth a visit, and here we observe the novel method of rowing adopted by our Intha boatmen as they take us across. Men and women are equally expert; standing at the bow and stern of the boat and balancing themselves on one leg, and holding the end of the paddle, they work the other leg over the upper portion of the blade, and propel it with their leg, merely guiding the paddle with the hand. They complicate matters further by frequently carrying a spear in the hand not occupied with the paddle, with which they transfix any passing fish. Their dexterity both with spear and paddle is wonderful. They supply all the bazaars in the neighbourhood with fish. At Fort Stedman you will be warmly welcomed by the regiment there, and if in the proper season will enjoy some excellent wild fowl shooting. At Taunggyi you will be hospitably entertained by Mr. Hildebrand, in a very nice house recently built for him by the Government. Comfortable and well-furnished with a pretty outlook, it gives one the feeling of being in a pleasant little country house in England; and this feeling will be strengthened when Mr. Hildebrand has perfected his plans for garden and orchard, already fairly stocked and yielding a good supply of English flowers, fruit, and vegetables.

Leaving Taunggyi, where the cart-road ends at the 105th mile, and threading our way among some low hills, we descend some broken ground to the town of Hopon, 3,400 feet above the sea. The huge white pagoda surrounded by a perfect forest of smaller spires is visible for a long distance. Round about rise many fantastic limestone peaks. The grassy slopes are covered with the bushes of he wild raspberry and blackberry, and a gigantic honeysuckle sheds its fragance in the air. To the east a lofty rugged range, rising to nearly 9,000 feet, presents a formidable barrier to our onward progress. Fortunately the path finds a comparatively low point at which to cross, and a somewhat stiff ascent and descent brings us to Sa-On, a pretty spot among the hills, where for the first time we see a curious, but common feature in this country. Above the village some rice fields are shut in by a limestone ridge; through these fields runs a little stream, which makes straight for this barrier; it flows under and round some fallen boulders, and then disappears in a little chasm behind. Some 200 feet below, and a quarter of a mile away, it emerges from a lofty cave, and flows calmly onwards, through the terraced rice-fields and the gently sloping valley. I have said this is a common feature in this country, and Lord Lamington describes a similar disappearance on a very large scale at Mong Hang. I had too much work to do while I was there to find time to visit this spot, but Lord Lamington's account is as follows:—"The cave where the river enters on its subterranean course is in a sheer face of rock some 200 feet high. The height of the cave is about 140 feet, its width at the entrance 300 feet, broadening in the interior to nearly 500 feet; the depth is about 300 feet. At the right-hand bottom corner, a tunnel, at an angle of 45° with the cave, provided a passage for the river. I followed this for some distance, but with no other result than that of getting wet. It is said of this cave that a cut teak log floated down never reappears, whereas an entire tree, with its root and branches, makes the journey successfully." I heard a similar statement. Some of the members of Mr. Elias's Mission, in 1889, attempted to visit this cave, but were unsuccessful. From Sa-On another long ascent and descent brings us to the plains of Möng Pawn, a large place, the seat of a Sawbwa. The Nam Pawn, a broad but not deep stream, here winds among the fields, which it irrigates by means of large bamboo water-wheels, commonly used in these States. These wheels are also used to work sugar-crushing mills. Below Möng Pawn, the river increases in volume, becomes confined in narrow gorges, and forms an unpleasant obstacle on the road between Taunggyi and Moné. A lofty range lies between Möng Pawn and Ban Ping, the descent to which was exceedingly steep and unpleasant for man and beast before the Sawbwa improved it; from Ban Ping to the Tein river, the path lies once more over open undulating ground. The next river reached, after crossing some elevated table land, partly open, partly through forest, is the Ben Chaung (the Burmese name) or Nam Pong (the Shan name) a very beautiful river which joins the Salween ten miles below Kenghkam. At Kenghkam it is a quarter of a mile broad, with lofty wooded hills on either bank; wooded islands breaking up its channels. Curious parallel ridges of rock rise to within a few feet of the surface in the cold weather, but the water is very placid here, though just above it descends over a series of cascades among trees and shrubs which grow in lines and clumps right across the river. Again, at many points in its course falls of 30 to 40 feet occur, and as it approaches the Salween, where the lofty green hills close in on it, it rushes down a steep descent in one long roaring rapid, for several hundred yards, a mass of foaming, white, tumbling waters. At Kenghkam, the river is crossed by boats, one of the regular ferries being here. The village itself is pretty, and a fringe of cocoanut trees curiously recalls Ceylon. The height here is 1,200 feet. Ascending gradually, for about twenty miles to a height of 3,000 feet, a somewhat abrupt descent brings us to the Salween at the Takaw ferry, situated 800 feet above the sea. The river here in the dry season has a width of from 150 to 200 yards, and a total width between the banks of 400 yards. The river rises some 40 to 50 feet in the rains. The right bank here is steep and rocky, but on the left bank is a broad stretch of sand bank and flat stones. The Salween is the Burmese name, the other name of the river being Nam Kong. From the Salween to Keng Tung the road is a constant succession of ascents and descents over hills covered with pines and other timbers of large growth. Two small oases occur in the valleys of Mong Pu-Awn and Mong Hsen. The former is a collection of scattered villages in a long, narrow flat valley, under rice cultivation. In the monastery here I first noticed an approach to the style of ecclesiastical architecture obtaining in the Eastern States. An ascent of 3,000 feet brings us at 5,000 feet above sea to the grassy wind swept knolls of the Hpamin, a Palaung village, one of a group of six, where the poppy is extensively cultivated. Mong Hsen is situated in another sheltered cultivated valley, which in spring-time is a garden of flowers, the large white single rose, discovered by, and named after, General Sir H. Collett, growing in wild profusion. The valley is closed to the south by some high precipitous hills, into which the two streams which water Möng Hsen disappear within a quarter of a mile of each other to find their way on the further side into the Nam Sim. At Loi Pemong the highest point of the road is reached, where it crosses the water parting between the Salween and the Mekong, at a height of 6,000 feet. Here we get our first glimpse of Keng Tung and its fine plain lying some 3,000 feet below us. This plain is about ten miles long and varies in width, its average breadth being about five miles. The huge spurs from the high ranges on either side break up, as they descend into the plain, into gentle undulations. To the north and east the plain is perfectly flat and covered with rice-fields, intersected by irrigation channels: to the south are gently swelling downs and low grassy hills, swampy hollows lying between. The town of Keng Tung covers some undulating ground on the western side of, and overlooking, the plain. Its walls have a perimeter of some five miles; they follow the undulations of the ground, standing highest above the plains on the north, where a pagoda, with a curious umbrella-like tree growing from its summit, forms a striking landmark. The walls, which are somewhat ruinous, are crenelated and loopholed, and protected generally by a formidable ditch some 25 feet deep, and V-shaped—a very difficult object to negotiate at the best of times. Where the walls descend to the level of the plains the ditch disappears, but marshes cover this portion. There are several arched gateways, protected by brick and earth traverses; one to the south gives egress to the road leading to a fine large tree called "Execution tree," where, under its spreading branches, executions used to take place on the large market days. The prisoners were led through the crowds in the market, and given drink at the various liquor booths. A strong escort with bamboo ropes kept off the crowd. At the place of execution the name of the condemned man and his crime were read out by the official in charge of prisons, &c. (a court minister), and the slip of bamboo on which they had been written tossed over the man's head. He was then made to kneel down with his arms tied tightly at the elbows behind his back, and was decapitated with a long knife. The head was not held. This is evidently similar to the Chinese method of execution.

There is very little level ground within the walls of Keng Tung, and only the northern and eastern portion of the space enclosed is built over; and even this portion is somewhat overrun with trees. There are several weedy swamps, the largest being Nong Tung, or the lake from which the town takes its name. The Sawbwa's palace stands close by, and is a fine collection of teak buildings, well and solidly constructed, and surrounded by a brick wall. There are from 1,500 to 2,000 houses inside the walls, and these are substantially built, some with brick basements, the upper walls of planks or bamboo matting, some with the side walls of the upper story also of brick. They are roofed with small well-made tiles, which afford protection against fire. The monasteries and churches are very numerous, and each stands in its walled enclosure.

The difference in style between these and the ordinary Burmese, or Western Shan Phongyi Kyaung, is very striking, and is due, Mr. Scott thinks, to Tartar influence. He says, "This is particularly noticeable in the massive gateway which immediately suggests the *Paifang* of China. The resemblance is no doubt due to the fact that the brickwork was run up by Chinese or Shan Chinese handicraftsmen. There is no similarity whatever to the steep-roofed, parti-coloured tiled gables of the Bangkok 'Wats.'" The churches are adorned with elaborate carvings, mosaics of coloured and silvered glass, and frescoes. Each is built with a nave and two aisles, rows of lofty teak columns, painted red and gilded, support the roof, the timbers of which are also very ornate; the ornamentation is most elaborate above the high altar with its huge gilded figure of Buddha calmly meditating beneath its canopy of cut calico, which much resembles lace at any height. Frequently there is an ambulatory behind the altar, and then we find the altar with a highly ornate reredos. In front of the altar is a table for offerings of flowers, iron stands for wax tapers; a carved and gilt stand with a crucifix is supported by a wooden elephant; the arm of the cross carries a beautifully embroidered crimson silk or satin banner, covering napkins used for dusting the sacred images. Tall handsome wooden pulpits, carved, painted, and decorated with mosaics, are conspicuous objects in the churches. The priests' apartments in the adjoining building are comfortable, the chief priest's being recognised by the handsome gilt and jewelled chests, in which are kept the sacred records; gay carpets and rugs cover the floor. Incidents in the life of Buddha frescoed on the walls are diversified by some advertiser's flaming idea of Her Gracious Majesty, Napoleon, or Wellington, the latest skirt dancer, or Phil May's inimitable coster cartoons, cut from illustrated papers presented by the members of our various missions, and much prized. The Dean of Keng Tung, whose church is the most elaborate, is a fine, portly, elderly man, of great presence and unmistakeably an ecclesiastical dignitary. He has travelled to India and Ceylon. His monastery is very wealthy, and he is said to be possessed of personal wealth, contrary to the ordinances of Buddha. The clergy in the Eastern Shan States are generally less orthodox than those in the Western States and Burma, who call them "Htu" or "imitation priests," and regard them much as the priests of the Church of Rome regard priests of the Church of England. The eastern Phongyis travel about in great state, wear yellow caps, and carry arms. Many allow their hair to grow; some even cultivate moustache and side whiskers, and look like the Evangelical clergy. I made many friends among the priests and their young scholars while painting in the churches.

Outside the walls of Keng Tung are many large and populous villages. To the east of the town, lying under the wall, is a large colony of the Shan Chinese. They have been settled there for some time, and have a large and handsome church of their own. The houses are built of bamboo, and their village is very dirty. They keep goats, ducks, fowls, pigs, and cows. They are good gardeners, and we obtained some very good vegetables there in the spring. They grow lettuce, cabbage, onions, radishes, pumpkins, cucumbers, beans, French beans, peas, yams, and several kinds of sweet potatoes. They do a good deal of trade, and Mr. Scott considers that they introduced the manufacture of tiles into Keng Tung, and that the pottery — plates, cups, bowls, jugs, teapots, spittoons, pagoda ornaments, &c.—which are so varied in kind and so cheap in Keng Tung, is mainly their work. There are a few shops in Keng Tung in which cloths, tinned milk, and matches are sold. The big bazaar, or market, is held—as elsewhere in the Shan States—every five days. On three of the other days small bazaars are held in different parts of the town. There is no bazaar anywhere on the fourth day. On the fifth day, the large marketplace, with its lines of booths and stalls, is thronged with enormous crowds of people from the neighbouring villages and the surrounding hills. The quantity of goods displayed, and their variety, is very great. The vendors are Shan women and Chinese men. The articles on sale include English and Indian cotton goods and yarns, Manchester silks, handkerchiefs of the most startling patterns, aniline dyes, coloured paper, Japanese matches, pocket knives, needles, powder and caps, flowered rugs, &c. The butchers, who sell beef and pork, and the shoemakers are Chinamen. Chinese merchants also sell the huge straw hats with oiled silk coverings, which are made exclusively for the Shan market, raw silk, fur coats, iron pots, Chinese pipes and padlocks, also quicksilver and rock salt. These merchants arrive in December and having disposed of their goods make a trip or two to Moulmein, Rangoon, or Mandalay, returning with Manchester goods, which they sell off on the way up, or in Keng Tung, and return home in May laden with cotton. Western Shans also come here to trade. They bring *das*, cutch and piece goods. They usually take back bullocks. There is a tendency on the part of some of these traders, principally well-to-do Taungthus, to settle down in Keng Tung, their wealth recommending them as husbands to the fair ladies of that place. Traders from Siam bring raw silk for sale, taking back opium from Möng Lem and the Wa States. The Sawbwa and principal ministers invest their money in opium, which is considered the most paying article of trade. The country women bring to market excellent cheap oranges, bananas, plums, yams, beans, peas, onions, ground and water nuts, pressed water grass (to be eaten with curry), jaggery, cheap and fairly good tobacco, and shamshu. Silks are woven by women of the town, and considerable taste and skill are displayed in the patterns and blending of colour. Cotton cloths of good design and well woven are brought in for sale by the hill tribes. The restaurants, where cooked food is sold, are numerous, and ocular evidence supports the idea that the trade in liquor is a large one. Fish, mahsheer, murrel, &c., are caught in the Nam Khün and Nam Lap, and are kept in little ponds for sale in the bazaar.

Gambling is universal in the Shan States; and on market days respectable-looking men may be seen seated in a booth, or some other shelter, selling tickets from little books for the lottery of the "thirty-six animals," a diagram of which hangs behind him to assist the investor in making his choice. In a central spot is a tall bamboo, from the top of which dangles a small box containing the name of the winning animal for the day. This is hauled down at a certain hour, and the winners declared. Other forms of gambling—odd and even, a rough kind of roulette, &c.—are also in full swing. Attempts are being made, with some success, in the Shan States, to reduce the excessive public gambling, but as the receipts from the licenses are very great, and in Keng Tung a portion is set apart to provide pin money for the queen and princesses, the reform must not be effected too violently. It has been pointed out to the chiefs that, in the interests of the people, they are now exempt from the octroi and bazaar dues, monopoly on tea, and other collections exacted by the Burmese kings.

The Sawbwa is assisted in his government of the State by sixteen ministers. These are not paid any settled salary, but receive a certain proportion of fines, taxes, &c., and are often very poor; the daughter of the prime minister keeps a vegetable stall in the market. The State is divided into districts, each under a Hpaya, or commissioner, with four or five advisers, who are invested with certain magisterial, civil, and revenue powers. These hpayas have the power of life and death without reference to the Sawbwa. Each district is subdivided into village circles under their own head men.

The present youthful Sawbwa, a young man of somewhat violent temper, is more feared than loved by his people. His *amours* are numerous, and he seems to bear a similar character to that of Henry VIII. He is, however, said to be straightforward. He gives his ministers an audience every fifth day, when they make verbal reports of their proceedings; these he confirms, or modifies if necessary, also verbally.

I am indebted to Mr. G. C. Stirling, Assistant Commissioner, and an intelligent young Burmese official, Maung Nyo, our agent at Keng Tung, also to Munshi Abdur Rahim, one of my assistants, for much of the following information concerning the laws and customs of the Shans.

Crimes, theoretically punishable by death, are murder, dacoity, theft of valuable property; but under ancient custom, every offence may be expiated by a money payment, unless, in case of murder, the murdered man's relations demand blood for blood. The price of an ordinary man or woman's life is Rs. 300, of a woman's body, Rs. 80 (claimed in cases of adultery). A chief or high official is worth more, but in each case the death penalty is usually imposed. In cases of culprits who cannot pay, or whose relations cannot pay, death is looked upon as a fitting punishment even for petty thefts. Of course our influence is being used *pour change tout cela*, but, so far, success has not been conspicuous. Relatives of criminals are held responsible for the latters' misdeeds, and in case of horse or cattle theft, or of dacoity, a whole village or even small township is dropped upon, should the immediate relatives fail to pay the required compensation. Civil cases, divorce, inheritance, and the like, follow the laws of Menu, as in other Buddhist countries. Fees, in civil cases, are regulated by the rapacity of the judge, and are generally exorbitant.

If the scenery of the Shan States is varied the tribes inhabiting them are still more diversified. It will be impossible in this paper to do more than indicate them. We may divide them into (1) the dwellers in the cultivated valleys and alluvial hollows, (2) the various tribes living on the hills. The former are those whom we know as Shans. "Shan" is a Burmese word, and is supposed to have the same root as Siam (Sciam of old maps). British Shans generally call themselves Tai—in Siamese "Htai." The inhabitants of Keng Tung call themselves "Hkön;" of the Hsip Hsaung Panna (Keng Hung), and adjoining districts "Lü." Both, however, answer to the general name of "Tai." The alphabet of the Western Shans is founded on the Burmese: those of the Hkön and Lü, which are identical, are very complicated, and the main features resemble the Siamese. The spoken language of all is the same, though there are great dialectic differences.

In all fair-sized villages there is at least one doctor, and the druggist's stall is conspicuous in all bazaars. The methods of the Shan medical man have not been thoroughly investigated yet, but very many of their drugs simply appeal to the faith of the patient.

No great fuss is made over marriages. The ceremony varies from the simple arrangement of taking each other's word for it, to feasts lasting several days among wealthy people. Even here, though, the actual ceremony is a minor feature in the proceedings. The usual form among Western Shans is for the couple to eat rice together out of the same dish in presence of their relatives and the village elders. The bridegroom then declares that he marries the lady, and will support her. Among the Lü there is more of a ceremony. The hands of bride and bridegroom are tied together with a piece of string after they have eaten together, and an old man pronounces them duly married. The Hköns throw rice-balls at each other and the couple during the ceremony. The newly-married couple then go to their house, and split betel-nuts are distributed among the relatives of the bride, who give money as a return present. Divorce is readily obtainable, but except among young people of low rank, is comparatively rare. A man can have more than one wife if he can afford it. In case of divorce the property is divided according to the laws of Menu. The applicant for the divorce (when the desire is not mutual), or the person through whose fault the divorce is applied for, always loses considerably in the division. Shans bury their dead; priests and chiefs are burnt.

Like the Burmans, Shans believe in lucky days, and soothsayers are consulted to fix a day for any public undertaking, for commencing a journey, &c. Their superstitions are many and various. Being Buddhists they are ashamed somewhat of worshipping "nats" (spirits). Buddhism gets more corrupt the further East one goes, and nat worship gains in strength. Buffaloes are openly sacrificed to the nats east of the Salween, a thing rarely seen in the west. Certain nats are only appeased by human sacrifice. The guardian spirit of one of the Salween ferries claims a victim every year—preferably a Chinaman. The nat saves trouble by capsizing a boat and securing his victim. The ferry is then safe for the rest of the year. Shans still believe in the efficacy of human sacrifice to procure a good harvest. The manner nowadays is to poison someone at the State festival held generally from March to May. The practise is discountenanced by the chiefs, Mr. Stirling says, and is probably dying out, but he has known more than one instance of it.

Shans believe in witchcraft. Mr. Stirling has known instances of women (sometimes young women) being expelled from a State, and all the property of their relations confiscated for supposed dealings in the black art. Maung Nyo, in a letter lately received, says, "Some days ago while I was walking in the town I heard a good deal of firing, and on inquiring the cause, was told that the house of a witch was being burned down by order of the Court. I at once went to the scene of the fire. The witch in question is supposed to have killed nine persons during the last two or three years; and the people have just discovered the fact; so the witch was driven out of her house which was burned. While it was in flames many guns were fired off to drive away the witch's spirit, or familiar, which might try to remain. The Shans believe that while a witch's house is being burned the adjacent houses will not catch fire, however windy it may be. In this case the adjacent houses were a little apart, and well soaked with rain, and no wind was blowing. No violence is said to have been committed on the witch, but her property was looted or confiscated."

Rice is grown everywhere in the Shan States. There are two systems of cultivation, one on terraced and irrigated land, the other on the hill sides. The former is that adopted by the Shans. There are three crops; the first grown in dry weather on land altogether artificially irrigated; the second on lands wetted by the first rise of the streams; the third and main crop during the rains. Very pretty little fenced-in gardens are common along the banks of streams flowing past the villages.

The Shans never use bullocks for ploughing, only buffaloes. Their hills were lately visited by the cattle plague, from which they suffered severely. The Shan States are supposed to be a great pony breeding centre; this, Mr. Stirling says, is not now the case, and even in the palmy days of the States, breeding was more or less confined to the Northern States. The most successful breeders were supposed to be the Palaungs.

I have neither time nor space to tell of all the various hill tribes to be met with in this interesting country. The principal are Kaw, Kui, Kun Loi, or Tai Loi, Miao, Mühso, or Lahu, Palaung, Lauten, Taungthu, Wa, Yangsek, Yanglam, Yao Yin. Of these the Taungthu, Yangsek, and Yanglam tribes are found among the Western Shans. The Palaungs are found all over the Shan States. The others live to the east of the Salween. The men generally wear the Shan dress, and only the women's dress enables one to determine the tribe. The Yangsek are considered to be allied to the Karens, but I believe, have a language of their own. The women wear curious long coats, like sacks, with holes for the head and arms, very short sleeves, with alternate white and red longitudinal stripes. The Palaungs are widely distributed. The approaches to their villages are always good, and the excellence of the roads in the tracts inhabited principally by them is noticeable. There is one large Palaung tract in the Keng Tung State, and in this tract lies the Samtao circle of villages, where the guns are made which are sold in Keng Tung. Till lately, these were of the long gas-pipe style, with flintlocks; now, Captain H. B. Walter, D.C.L.I., of the Intelligence Department, who visited the Samtao villages, tells us they manufacture muzzle-loading percussion cap guns —rough, though accurate, copies of the Tower musket—which finds its way into every corner of the Burmese Empire. They also manufacture pistols of a Tower musket pattern. These Palaungs are Buddhists, and in some of their villages very handsome little "wats," or churches, are to be found.

In Captain Gordon's report on his last winter's survey work in the Myelat—that portion of the South Shan States lying west of Fort Stedman—he says there are over twenty different tribes distinct in dress, customs, and often language. These tribes do not, as a rule, intermarry. They are unambitious and unenterprising, but cheerful and fond of amusements, and although constitutionally lazy, work hard enough to keep themselves in comfort. The wife does all the housework, and a large share of the outdoor work as well. At a Taungthu village, which had suffered severely from the cattle plague, I saw a woman dragging the plough which her husband guided. So important a member of the household is she considered, that, in most of the States, a widower is exempt from all taxation. Captain Gordon also says this country is rich in minerals; lead ore is extensively mined in the Baw Saing State, where the ubiquitous Chinaman, who is always to the fore where money is to be made, holds the contract for melting lead and silver. The possession of this mineral wealth is not an unmixed benefit to the State, as the hills are so honeycombed with old mines that the people cannot keep cattle, grazing being impossible owing to these pitfalls. Coal of fair quantity is found in Pwehla, and copper and iron were both formerly mined for in the Myelat. Legya is now noted for its iron work.

Crossing the Salween we meet the Muhsö, a tribe rather widely scattered over the hills in the western part of Keng Tung and the northern border of Siam, where Lord Lamington came across some of them. Capt. H. R. Davies, O.L.I., also of the Intelligence Department, a good linguist and Shan scholar, says the word Muhsö is identical with the Shan word for "hunter," possibly because they are notoriously good Shikaries. They call themselves Lahu. They are again subdivided into 16 tribes. They have come from China and many are said to live there still. In complexion the Muhsös are fairer than the Shans. Their noses vary a good deal, some being straight, some very flat—oblique eyes are especially noticeable among the majority, and a Chinese cast of countenance decidedly prevails. They have a curious custom at their annual festival which begins on the Chinese New Year's-day, towards the end of January, and lasts five days. The village is "Taboo" for that time. The paths to it are blocked by bamboo erections and symbols warning off the stranger, who, if he persists in entering the village is kept there till the feast is over; everything he has, including his clothes, is taken from him, and he is sent naked away. The Muhsö say that the spirits are displeased at the presence of a stranger. The spirits have a house in each Muhsö village, which is fenced off, and surrounded with ornamental posts. These posts are renewed at the festival. During the five days the people dance, sing, play musical instruments, and fire off guns. The dance is a slow one, in a circle, each dancer being also a musician. They have, too, two musical instruments, one a gourd, in which several small bamboos are fixed, the sound produced being somewhat like a harmonium. I have heard, from a hilltop, the Muhsö wandering, unseen, in the jungle below, playing these instruments as they went; and the soft, sweet low tones suggested the presence of wood nymphs. The other instrument resembles a jew's-harp, made of bamboo. Though strangers are not allowed into the village during the festival, the villagers may wander outside; and the men of a large village came to my camp one night and gave me a great entertainment, the women coming as spectators.

The Kaw tribe is very numerous throughout the whole of the eastern portion of Keng Tung and in Keng Cheng. The men are taller than the average Shan; their features suggest the Chinese type, and they wear pigtails tied up inside their puggris, and ornamented with small silver discs. They use the same musical instrument as the Muhsö, and their dance is similar. Mr. Scott graphically describes it thus: "A sort of figure which suggests the Highland fling performed by a man in the last stage of exhaustion." Of the women, Mr. Scott says: "They are very small, and wear a complicated dress which exposes portions of their person in rather unexpected places. They wear cloth leggings, and the married women have an exceedingly elaborate headdress made of bamboo, and hung round with festoons of seeds and shells."

The prettiest women's dress we saw was that of the Miao, a Chinese tribe with whom we first come in contact on our Eastern borders. It consists of a jacket with an elaborately worked sailor collar, a full, pleated petticoat and pretty apron, with a neat grey puggri.

The La Was are the most savage of all these tribes; they were supposed to be cannibals, but this has not been proved against them. Their villages are perched high up on the mountains, off the regular paths, and few have visited them. They are head hunters, and the accounts given of the approaches to their villages, through a grisly avenue of posts, each post bearing a human skull, recall similar customs in the Naga Hills, Assam. Like some of the Naga tribes, also, the Northern Was are said to go about naked.

Time fails me to tell of others: not minutes, but hours, would be required to give the information we have about them all; and even this is far from complete, and I am quite in accord with Mr. Warry, who writes:—"It is a matter of marvel to me that nobody has as yet thought it worth his while to come out and study these tribes in their own country. The Abbé Huc's professor of geography discovered a new island without going outside his library, and discoveries equally startling may perhaps be made by the stay-at-home philologist. But here are rich stores of knowledge, which can only be collected and turned to account by a qualified student willing to spend some years in the country itself. In the north and north-east parts of Shan land are found a mixture of races and a medley of languages without parallel in any other part of the world. The tribes I have just given a slight account of are but a few of the whole number. The chance of studying these peoples to full advantage is fast slipping away. Up till now, they have been almost entirely isolated, owing to the insecurity which has prevailed in the regions where they are settled. In consequence, they have, no doubt, preserved their languages and institutions in a far purer state than members of the same races who have lived under happier, and more peaceful conditions elsewhere. Now, however, an era of peace seems to have set in. These tribes are in constant contact with the outside world; their languages are undergoing modifications, or dying out, and their customs are being assimilated to those of the Shans and Chinese. Many illustrations of this have come under my observation during the past half-year. I would, therefore, recommend any one who is interested in such inquiries to come before it is too late; the inducements are surely sufficient: a good climate, in the midst of splendid mountain scenery, simple, friendly folk to live among—I never required an escort while engaged in my survey operations—"and an occupation full of interest in itself, and sure to lead to results of permanent value."

A few words before I close concerning the communications. These are confined to a few well-defined tracks, and these are not very good, even for pack animals. The path from Taunggyi to Keng Tung was last summer widened and improved, and made into an excellent mule track, where two laden animals can pass each other without one of them going over the side. This work reflects great credit on Mr. Litster, executive engineer at Fort Stedman, and his assistants, who carried it out at a very unfavourable season, and in the face of great difficulties.

I do not think that sufficient expert exploration has been done with a view to improving the communications and developing the resources of the country. The navigation of the Salween might possibly be rendered easier, and the teak trade would be largely benefited by increased facilities for exporting it.

You are aware that work has been begun on the line of railway from Mandalay to the Kun Lon ferry on the Salween. It is hoped that it will tap the trade of Western Yunan. I should have been glad to see a line run up on to the Southern Shan-plateau, at least, if not to the Salween itself. The construction of the cart road to Taunggyi has had most excellent results; but a line of rail would, in the opinion of many qualified to judge, greatly increase the agricultural wealth of the country. Potatoes have already been very successful, the cultivation of wheat should be very remunerative, and a brisk trade in vegetables and fruit might be established, while as Mr. Hildebrand says, there is a pasturage for sheep equal to that of the Wiltshire downs. This line, I venture to think, would be most useful both strategically and commercially.

The climate of the Shan States is generally good in the cold weather. The nights are cold till April, and the heat, though great in the valleys, is seldom so oppressive as at Mandalay or Rangoon. Frost is experienced in some parts, but snow, of course, never. The valleys, owing to the mist and damp, are generally colder than on the hills above. The rains begin in the end of April, or beginning of May, but there is frequently a break of a week or a fortnight at the end of May. Good hill stations for troops could easily be found; and the sickness we hear of at Keng Tung and elsewhere is probably due to imperfect housing and the selection of indifferent sites.

The inhabitants of the Shan States suffer from fever in the low-lying valleys, and smallpox is an ever-present scourge, as the disfigured faces of too many Shans evidence; influenza also has, I believe, invaded even this distant and uncivilised tract.

DISCUSSION.

Sir CHARLES CROSTHWAITE, K.C.S.I., said he had been much interested in listening to the admirable account which Colonel Woodthorpe had given of the Shan States. It was a country full of interest to any one who studied the languages, customs, and peculiarities of different races of mankind. To him it was more interesting from an administrative point of view, for when he was in Burma they had so much to do in preventing the people cutting each other's throats that there was little time for studying their languages or customs. As a matter of administration, the work of Mr. Hildebrand, the Superintendent of the Shan States, was one of the most interesting episodes in the history of India. Very little was known of this country by the general public, or was likely to be known for some time. Perhaps the extraordinary names they bore, which it was almost impossible for an Englishman to pronounce, made the accounts of these places rather distasteful reading to the majority. He hoped, however, that more interest would be taken in this remarkable country and people, of whom he could narrate many anecdotes, but would confine himself to one or two. The first Sawbwa of the Shan State who came in and acknowledged the British supremacy was one whose connection with it began in this way. In 1883 and 1884 he was a refugee from the tyranny of the King of Burma, and came down to Rangoon, and one of his habits was that of very freely using his repeating-rifle if he were displeased. One day when he was living in the suburbs of Rangoon, being annoyed at something said or done by two of his servants, he shot them both. He was arrested and tried, and the Recorder of Rangoon sentenced him for murder, though he pleaded that he was an independent prince, and had the right to kill his own subjects. He (Sir C. Crosthwaite) saw him in the Rangoon jail, where his head had been shaved, and he had been set to the task of grinding wheat, which he was doing like a man, though he was between 50 and 60 years of age. The Government using its prerogative interfered on his behalf with the ordinary course of the law, and he was treated as a civil prisoner, but was kept in durance for some time. Either in consequence, or in spite of, this treatment, he became a firm friend of the British. He came down to Mandalay as soon as he heard of the arrival of the Chief Commissioner, and had behaved with the greatest loyalty ever since. Within the last few years he had sent his two sons to be educated in England. Sir Charles Bernard, with his usual goodness, took charge of them; one went to a public school, and the other, after a course of private study, including mining engineering, had gone back. The whole history of the annexation of the Shan States was of great interest, and the way in which Mr. Hildebrand managed to conciliate the petty jealousies of the various chiefs, and to secure order, almost without firing a shot, was a striking example of personal influence. He was greatly aided by Mr. J. George Scott who had been lately engaged on important work in connection with the Siam boundary, and by Captain Hugh Daly, now in the Foreign-office of the Government of India; and the names of those two men should be held in the highest honour. The first party which was sent to Keng Tung, the place of which much has been said by Colonel Woodthorpe, was under Mr. Scott. He had an escort of 50 military policemen only, and a transport train of Panthays. When they reached Keng Tung, some festivities were going on in the enclosure of the Sawbwa's palace, and some of the Panthay muleteers went in to look at what was going on, carrying their usual short swords with them. An altercation ensued, the young Sawbwa came out and used his rifle, killing two Panthays and wounding another, and there seemed a chance of the whole town rising and falling on Mr. Scott and his small escort. Mr. Scott acted with his customary firmness and spirit. He summoned the Sawbwa to his presence, and ordered him to pay within a given number of hours a heavy fine for the violence he had committed, under threat of punishment should he fail. The fine was duly paid, and the Sawbwa of Keng Tung became an obedient feudatory to the British Government.

Lord LAMINGTON, K.C.M.G., regretted that he had not heard the beginning of the paper, but he fully agreed with what was said as to the great future possibilities of the Shan country. There was such an amount of vegetation, the hills being clothed up to the very tops, that one could not doubt that if properly cultivated, it would amply repay any labour bestowed upon it. At present, the population was so scanty that there was no chance of doing much; but now that peace was secured, no doubt a great development would take place. Colonel Woodthorpe suggested that it would well repay anyone to inquire into the different tribal distinctions, and he fully agreed with that suggestion. It was exceedingly difficult for a traveller to distinguish between one tribe and another: the distinction was often only shown by the clothing, and that only in the case of the women. A photograph had been shown of the Kaws, and a good description given of their dress, but on the east side of the Mekong what were supposed to be the same people were found clothed in quite a different way. With regard to religion, the further you went East the less religious they were. He was glad to see Mr. Scott present, and also to see such a large audience, showing that considerable interest was taken in this newly-discovered region, which he was satisfied had a great future before it.

Mr. J. GEORGE SCOTT, C.I.E., said he came there firmly determined not to say anything, for though he had been for the last ten years more or less constantly engaged in the Shan States, he had had no time to put his ideas in order, and Colonel Woodthorpe's paper had pretty well covered the whole ground. He did not say, however, where the Shans came from; but in truth no one knew. M. Terrien de Lacouperie put them in Sechuan, but few agreed with him; and it seemed probable that they came from farther north. At the present moment, the Shans were found from Assamto beyond Tong King, and into Kwangsi, under the name of Tai. The Siamese, of course, were Shans, and they went by the name of Htai, or Great Shans; the others, no matter what they called themselves locally, were all simply Tai. The great difficulty about the study of the Tai language was that there were at least four different characters: the West Shans used one very like the Burmese; the Siamese had a character of their own, which was very like Pali; the Shans called Lü had another character of their own; and to the north of Siam the Lao Shans had another. The whole of the Shan States were very much alike, consisting of hills and valleys, the Shans living in the valleys, and the hills being occupied by a number of races who were absolutely distinct, and whose languages were not only distinct from that of the Shans, but from one another. Their languages would inevitably become extinct as time went on, and the people became more and more assimilated to the Shans, and it would be a great loss to ethnology if some one should not go there soon and study the languages and customs of these people. There was, for instance, a race of head-hunters, sometimes said to be cannibals (but that was a mistake), who were very interesting, and he hoped some one would find time to go and study them before it was too late. He must confess, however, that beautiful as some of the photographs were, it was not an easy country to travel in at certain seasons.

Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., said that he rose with no intention of taking part in the discussion on a tract of country of which he had no practical knowledge, but merely, as Chairman of the Indian Committee, to express the appreciation of the Society of Arts of Colonel Woodthorpe's kindness in reading to them a paper of so much interest, and to note their satisfaction at the presence of the right honourable gentleman who was presiding over their proceedings, whose singularly able writings and speeches on Eastern questions had charmed the public so much, and whose position in the Government would yet no doubt give him an opportunity of bringing his great practical experience to bear in the settlement of many of those questions. He would like to ask on behalf of the Society for a little information which might elucidate the interesting paper which had just been read. Were there, for instance, any gold mines in this frontier hill tract, or any other source of mineral wealth by which it might be made a remunerative possession? Was the country capable of being brought back to the high state of cultivation which Colonel Woodthorpe had described as existing half a century ago? Again, Colonel Woodthorpe had spoken to them of the advantages of a certain line of railway towards Keng Tung, which he recommended for construction; had he any idea of what such a railway would cost, and would it go through a plain or hilly country? Would it be possible to establish a local militia in these tracts, if such did not already exist? Colonel Woodthorpe's clever sketches, shown on the screen, did not seem to display the Shans as a very robust or martial people, but there could be no doubt of the advantages of enrolling them for their own defence, in certain eventualities, if such were practicable. He did not wish to take up the time of the meeting by any further observations, and would, therefore, only repeat what pleasure the paper had given to him and others who had listened to it.

The CHAIRMAN said all would agree that a more picturesque paper, or one dealing with a more picturesque country and people, had probably never been heard in that room, and as Chairman he had to convey to Colonel Woodthorpe the thanks of the meeting for the trouble he had taken in preparing it, and in so beautifully illustrating it by photographs and his own sketches. He thought the attention of the ethnologist, philologist, and comparative sociologist ought to be directed to this particular quarter of the globe. He had never visited it, but had sought information with regard to it as a student; but he could not imagine a more interesting study, for men with such tastes, than the languages, customs, superstitions, and habits of these tribes, who were so entirely dissociated from the rest of the world. Mr. Scott had referred to the Wahs, an eccentric tribe, who were called "head hunters," and urged that some one, who had more devotion for science than regard for his life, should go and investigate their simple ways; but really that was hardly necessary, for in the current number of the *Asiatic Quarterly Review* would be found a most interesting and humorous paper upon these people by Mr. Scott himself. He only hoped that the same gentleman would devote some portion of his time to putting on record the results of his ten years' observations amongst the Shans; it would probably occupy him some months, but would afford material for years of study to his readers. The time for examining these people was the present. The British system which had begun to embrace them within its clasp had many advantages, in that it brought the *pax Britannica* to their doors, and allowed them opportunity for development; but, on the other hand, it had the knack, which was in some respects unfortunate, of flattening out the social knobs and excrescences which were everywhere to be detected on the surface of national character, and which were nowhere so interesting as in the case of these tribes. They would benefit by peace and improved social conditions, but the world would lose by the gradual obliteration of those idiosyncracies of which they had heard, and which ought to be examined by competent students before they disappeared.

Colonel WOODTHORPE, in reply, said there was said to be a gold mine amongst the Was, but as Mr. Scott put it, "they prefer heads to haberdashery, and, therefore, no one had yet gone there either to sell clothes or to get the gold. He believed the state of things was very much improving, and that under a settled government the people who had been forced to migrate were now returning, so that districts which a few years ago were quite deserted, were now becoming settled again; and in a few years, they would probably be more flourishing than they were fifty years ago. There had not yet been sufficient expert exploration to determine on a line of railway, though several had been suggested. Mr. Hildebrand was firmly of opinion that one could be made at a comparatively small cost, much less than that of the one now being made from Mandalay to the Kun Lon ferry. He did not know about forming a militia; perhaps Mr. Scott would answer that question.

Mr. J. G. SCOTT said it was as impossible to drill a Shan as it was a Burman. There was a Pegu battalion formed in 1826, and the whole of the civil police were occupied in looking after it.

SEVENTH ORDINARY MEETING.

Wednesday, Jan. 22, 1896; R. BRUDENELL CARTER, F.R.C.S., member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bale, John Henry Fooks, Lynmouth, North Devon.
Keith, Nathaniel Shepard, Sandycroft Foundry, Hawarden, Cheshire.
Leckie, Charles Stuart, Borneo Company, Limited, 28, Fenchurch-street, E.C.
Mowat, Magnus, Pitmian-lodge, Granville-park, Blackheath, S.E.

The following candidates were balloted for, and duly elected members of the Society:—

Britton, Percy Wilson, 30, St. Mary's-road, Peckham, S.E.
Bush, George, 34, Cleveland-square, W.
Devonshire, James, British Thomson-Houston, Ltd., 38, Parliament-street, S.W.
Lock, William Henry, 6, Serjeant's-inn, Fleet-street, E.C.
Parshall, G. F., British Thomson-Houston, Ltd., 38, Parliament-street, S.W.
Pink, Thomas, Thornton-house, Thornton-road, Clapham-park, S.W.
Simms, Frederick R., 95, Billiter-buildings, 49, Leadenhall-street, E.C.
Taw Sein Ko, Secretariat, Rangoon, Burma.

The paper read was—

THE SUPPLY OF SEA WATER TO LONDON.

By FRANK W. GRIERSON.

The scheme I am about to lay before you is, in one sense, not a new one, inasmuch as an Act of Parliament was passed a few years ago, incorporating a Company for the Supply of Sea Water to London. Satisfactory arrangements having been made with all the local authorities and other bodies affected, the Act was passed as an unopposed measure, the scheme being viewed with favour by the said bodies. The powers granted by that Act were, however, allowed to lapse, in consequence of the great demands which were made by parishes, hotels, householders, and others for the supply of sea water for public and private purposes, convincing the directors that their plans had been laid on too small a scale, the authorised capital being insufficient to meet the requirements certain to arise. That Act contemplated the supply of about one million and a quarter gallons per day, whereas the present intention is to supply nine or ten million gallons per day; and the area in London to be dealt with now is much larger than that originally contemplated. In the sense that no inland town has yet been furnished with a supply of sea water, this is an entirely new scheme; and I propose showing that it is thoroughly feasible, at a reasonable cost, and that it will confer great benefit on London as a town, and on Londoners as individuals.

General Description.—On reference to the diagram, it will be seen that the intake from the sea is opposite Lancing, between Brighton and Worthing; it is placed at a considerable distance to the seaward of high water mark—almost at low water level—and can, therefore, admit the sea at nearly all states of the tide, which has there, at spring tides, a range of about 20 feet. That spot has been selected for the position of the intake as the sea there is remarkably free from contamination of sewage or other pollution.

The sea water will first be pumped into the reservoir or settling tank at Lancing, the bottom of which is about 10 feet below high water; this reservoir will have a capacity of 10,000,000 gallons. The water is thence forced to a reservoir situated near the summit of Steyning Round-hill. The pumps and machinery are all situated alongside the reservoir at Lancing. This is, therefore, the only pumping station in the whole system; it adjoins the railway, and is provided with its own sidings for coal, &c. The Steyning reservoir will be situated nearly 500 feet above high water level, and will have a capacity of 10,000,000 gallons. The sea water will flow thence, by gravitation, to a third reservoir, at Epsom, over 200 feet above high water level; this, also, will have a capacity of 10,000,000 gallons. From this reservoir the sea water will flow, by gravitation, to London, where it can be delivered under the pressure due to this head, which is greater than that which most of the water companies command. The sea water will be conveyed in mains the whole distance, and as there will be two days' supply in the Steyning and Epsom reservoirs together, the mains will be always full. It is a practical impossibility that they should ever be frozen.

It will be seen that the route of the mains is through Lancing, Bramber, Steyning, West Grinstead, Horsham, Capel, Dorking, Mickleham, Leatherhead, and Ashstead, to the reservoir at Epsom; thence through Ewell, Cheam, Morden, Sutton, Merton, Wimbledon, Mitcham, Tooting-Graveney, Streatham, and Clapham, to Battersea, where a branch main runs off for supplying that locality. Crossing the Thames at Battersea, the mains pass through Chelsea, Kensington, Paddington, Belgravia, &c., and ultimately to Victoria-park. Any of the places *en route* can be supplied.

On reference to the plan showing the position of the mains in London, it will be seen that the mains form two complete circuits. The westerly circuit traverses Kensington, Paddington, and Belgravia; the mains passing along Cromwell-road, Warwick-gardens, Addison-road, Uxbridge-road, Ladbroke-road, Pembridge-square, Bayswater-road, Stanhope-street, Connaught-street, Park-lane, Grosvenor-crescent, Belgrave-square, Pont-street, and Brompton-road. There will be a branch main up Queen's-gate to Kensington-gore. The easterly circuit comprises Mayfair, Oxford-street, and the Strand districts; the mains passing along Park-street, Wigmore-street, Mortimer-street, Charlotte-street, Bedford-square, Russell-square, Southampton-row, Theobald's-road, King's-road, Farringdon-road and street, Victoria-embankment Northumberland-avenue, Pall-mall, St. James's-street, Piccadilly, Berkeley-street and square, Mount-street, and Park-lane. From the eastern side of this circuit, starting from Farringdon-street, there will be a main passing along the Barbican, Curtain-road, &c., to Bethnal-green-road, terminating near the gates of Victoria-park. And from the southern line of this circuit, starting from Charing-cross, there will be a main passing along Whitehall and Parliament-street to Abingdon-street, terminating at the end of Great College-street.

From these various mains, service pipes will be laid to the adjacent houses and other buildings as required, and hydrants will be provided in the streets for the supply of water-carts, &c.

Municipal Purposes.—The first place to make habitual use of sea water was Ryde, more than forty years ago. Tynemouth was the next in 1872. Barrow-in-Furness, Birkenhead, Blackpool, Bootle, Bournemouth, Falmouth, Great Yarmouth, Grimsby, Gosport, Harwich, Littlehampton, Plymouth, Portsmouth, Shoreham, South Shields, Torquay, Weymouth, and other places, have since followed those examples. It is found that once watering with sea water is equal in efficiency to twice or even thrice watering with fresh water. Evidence of this fact would have been given to the Parliamentary Committees on the former Bill by the surveyors of some of the places named, had the Bill not passed unopposed through both Houses. Sea water keeps the road-surface moist for a long time, but without slush. It hardens and binds macadam roads, and forms a preservative crust which prevents dust from rising. It is the one thing needed to make wood paving perfect, as, by retarding decomposition of the street refuse, it will effectually prevent the annoyance of any smell arising therefrom, of which annoyance public complaint has occasionally been made; as wood paving is fast displacing granite and macadam, this is a feature of considerable practical importance. The proportion of salts in sea water is about 3½ per cent., or, more exactly, 36½ parts per 1,000. Of these, nearly 30 parts are chloride of sodium, or common salt, and about 3½ parts are chloride of magnesium; it is owing chiefly to the deliquesence of these salts that the roads remain sufficiently moist for so long. A ton of sea water contains about 220 gallons, from which are deposited 80 lbs. weight of salts. A water-cart will spread a ton of water over a surface of from 1,900 to 2,000 square yards.

The cost of sea water for street watering in London will be most probably less than that of fresh water; but were it even the same, the advantage and economy of sea water would still be great, because—(1st) the quantity used would not exceed half; (2nd) the cost of distribution, horse wear, &c., would be correspondingly reduced; and (3rd) the roads would last longer in sound condition, and cost less to repair. This is the recorded experience of the places already named. In the hottest weather, when water is most required, there is now too often a difficulty in getting sufficient water for the streets, whereas the sea could never run short.

The use of sea water for flushing sewers is found to be decidedly beneficial; decomposition is retarded, and the sewers are kept cleaner and become more wholesome when sea salt is present in them. The borough surveyor of Great Yarmouth, for instance, stated that from his experience the advantage of being able to flush the sewers with sea water was alone worth the whole cost of the works for the supply of sea water for all purposes. His experience is that the effect of flushing with salt water has been to thoroughly cleanse the sewers, and that no nuisance from its use has been created, whilst owing to its greater specific gravity he considers it more valuable as a flushing agent. Its effect in the Yarmouth sewers has been to reduce, and, in fact, almost entirely to prevent the generation and accumulation of sewer gas. Sewers which could not be entered by the sewermen until the manhole covers had been opened several hours can now be entered by them, and have been entered, without any inconvenience, immediately on the removal of the manhole cover.

As nearly as can be ascertained, about 40,000,000 gallons of fresh water are now daily consumed in London for non-domestic purposes. This water has been filtered for drinking, but it is nearly all consumed in requirements which might be better satisfied by the use of sea water.

Sea water will be available for use in extinguishing fires. It will be on constant service under good pressure, and can be obtained from the hydrants at any time in abundant quantity. There will no hunting for turncocks, or having idly to watch a fire progress owing to insufficient supply or absence of necessary pressure.

Public parks, such as Battersea and Victoria, could be supplied with salt-water bathing lakes, and swimming therein would offer a greater attraction than swimming in fresh water.

Public baths, which are fast increasing in number, will also be supplied with sea water. The fact that it is considerably easier to learn to swim in salt water than in fresh will, no doubt, make these institutions still more popular.

Within the last fortnight over 300 members of those London Vestries through whose jurisdiction the mains will pass have communicated to me their assent—in many cases a very emphatic assent—to the opinion that a supply of sea water to London would be of beneficial use for municipal purposes.

Hospitals, Schools, &c.—There is a general consensus of medical opinion as to the value of sea water to health. Medical evidence of the highest importance was laid before a Parliamentary Committee on a previous occasion as to the great benefit a large supply of sea water would be in connection with hygienic work, and as to the desire of the hospitals for the establishment of sea-water baths in connection with their practice. More than a hundred physicians and medical officers of health testified their approval of that project, as being of the first importance from a medical point of view. "It is impossible, as a matter of fact, ever to imitate the composition of sea water by putting into the water any salts; we may know its composition exactly, but we cannot make it." Although the residue of sea water may be collected and dissolved in water, the resulting liquid is not sea water, but only salt water, for the reason that a great many of those substances which are held in solution in the sea never become soluble again after they have once been precipitated. It will be easy to supply most of the hospitals of London with sea water—always available and abundant in quantity—at the same cost as fresh water, or even less. Every Board or other school in the neighbourhood of the sea-water mains will be able to have its own swimming bath, and many thousands of London school children thus greatly benefited in health, and even taught to swim.

From many leading members of the medical profession, I have quite recently received the expression of their assent to the opinion that a supply of sea water to London would be of beneficial use for both public and private purposes.

Hotels and Residences.—During the passage of the former Bill through Parliament, the demands of hotel proprietors and householders for sea water were so numerous, that it is pretty certain it will not be long after sea water is obtainable before a good house not so supplied will be an exception.

Saving of Fresh Water.—It will be remembered that a Royal Commission has recently reported on the present supply of fresh water to London, in view of its probable inadequacy in a comparatively short time. The present consumption is 200,000,000 gallons a day, of which, as nearly as can be ascertained, about 160,000,000 gallons are used for domestic purposes, and 40,000,000 gallons for municipal and other purposes; that is, 20 per cent. of the total supply is consumed for non-domestic requirements. Nearly the whole of this 20 per cent. might, with great advantage both as to economy and efficiency, be satisfied by the use of sea water, thus releasing or providing 40,000,000 gallons of fresh water a day for household purposes, and so practically increasing the present supply to that extent. This is equal to an increase of 25 per cent., without any extension of fresh water works or further drawing on the present sources. This fact, apart from other considerations, affords a weighty reason for the speedy realisation of the present project, and its extension to the whole of London.

The Royal Commissioners reported that by extensions of the present works, and by further drawing on the Thames and Lea, the existing sources might be made to supply 420,000,000 gallons a day, and so be adequate for the wants of London for another 36 years; taking the then population at 11,250,000, and the consumption at 35 gallons per head, London would then require not less than 385,000,000 gallons a day. From the feregoing considerations, it follows that if sea water were used for all municipal and public purposes, and fresh water only for household requirements other than baths, the existing sources of supply would remain adequate for a population of 15,000,000, which London cannot reach till 1950, supposing the rate of increase to remain the same as from 1881 to 1891.

Fresh water is now supplied for public purposes at an average price of about 9d. per 1,000 gallons. Sea water could well be supplied at a less price for such purposes; but taking into consideration the greater efficiency of sea water for street watering, &c., as before pointed out, the saving, even at the same price, would most probably amount to one-quarter or even one-third of the present cost to the ratepayers.

Cost and Time.—The cost of the complete carrying out of this project will be £450,000. Sea water will be supplied by meter for public purposes, hospitals, schools, &c., at a price not exceeding the present charge for fresh water, and it is intended to supply householders also by meter at a price which will be only a fraction of the present cost of fresh water.

The construction of the works could be completed in about two years, so that if the Bill which has been deposited is allowed to pass with only those moderate protective clauses which the promoters will willingly accord, thereby averting the necessity of going before a committee on opposed Bills, the Royal assent will in all probability be obtained in June or possibly before that month, in which case large numbers of Londoners will, in the summer of 1898, be able to enjoy the luxury of a daily bath of real sea water in their own homes.

Experience.—It only remains for me to lay before you the experience gained as to the effect of the use of sea water for public purposes in the chief places where it has been so used. The following information, compiled from authoritative statements, sums up the experience of several years. It will be seen therefrom that the testimony in favour of the use of sea water for street-watering is practically unanimous, Hastings being the only case not absolutely and strongly favourable, and also that there is a vast preponderance of experience in favour of its use for flushing sewers, &c. The information given with the date 1887 was obtained by the Borough Surveyor, of Ipswich, from the surveyors of the towns named, with a view to the installation of a sea-water supply in that town, but owing to the existence of an exclusive clause in the Act of the Water Works Company which supplies Ipswich, it was found impossible to carry out the scheme. The surveyor has, however, kindly given me permission to make the information public. The information given with the date 1891 was obtained by the Borough Engineer, of South Shields, from the medical officers and surveyors of the places named, and a sea-water supply has since been established in that town. The information given with the date 1895 was communicated to me last month by the engineers and surveyors of the towns named, and I desire to take this opportunity of thanking the municipal officers who have so kindly favoured me.

Effect of the Use of Sea Water for Public Purposes.

Barrow-in-Furness.—(Used for street watering).—I am greatly in favour of a sea water supply. It occurred to me when I first began to use sea water for street watering that it might have in time a prejudicial effect on the macadam. I therefore selected two lengths of the same street, and had one watered with sea water and the other with fresh water, and found after an extended trial that the sea water had no such effect, while for keeping down dust it is immensely superior to fresh water. Sea water cakes the surface of the road, which remains damp much longer; it binds the top layer of stone, and improves the condition of the road in summer to a marked extent. 1,000 gallons of salt water equal in efficiency for street watering 2,000 to 3,000 gallons of fresh. The scheme will be much extended. (1895.)

Berwick, Places near.—(Used for street watering).—Salt water is very effective on roads made or repaired with flint or granite. It has a binding tendency, and causes a skin of adhesive matter to form on the roadway. One third the quantity of salt water on wood will keep it in a more moist state than fresh water will, with no injurious effects. No complaints of salt water affecting the stock of any shopkeepers, and no offensive decay of street refuse caused. All parties having control of street watering should use salt water where it can be had, from an entirely economical point of view, as well as for the comfort of the inhabitants. One cart of salt water is, in my opinion, equal to two carts of fresh water, giving a more lasting and beneficial result. Our macadamised roads that are watered with salt water are a pleasure to drive upon in the summer season, in comparison to those watered with fresh water, as we never seem to have a loose stone upon them. (1887.)

Birkenhead.—(Used for street watering).—Salt water does not injure granite roads. No offensive decay of street refuse is caused. Its use is economical, inasmuch as one spread of salt water is equal to at least three spreads of fresh water. (1887.) It is found that sea water is effective for a longer period than fresh water. (1895.)

Blackpool.—(Used for street watering and sewer flushing).—We use salt water for street watering and flushing sewers, in fact, for a great many purposes. (1887.) Streets watered with salt water do not require to be watered as frequently as with fresh water. (1895).

Bootle.—(Used for street watering, sewer flushing, and public baths).—Find it more economical as to cost than fresh water, and for several purposes it is decidedly better. (1895.)

Bournemouth.—(Used for street watering and sewer flushing).—No objections arise to the use of sea water, no nuisance is caused by the admixture of sea water with sewage. For flushing sewers it is quite as good as fresh water if used in sufficient quantity. It is much more effectual than fresh water for watering roads; one application of salt water being equivalent to three of fresh. The use of sea water on a hard road exposed to the sun or wind causes a sort of glazed condition of the surface. It is in favour with the shopkeepers and public generally; no disagreeable smell is caused, and no complaints are received. (1891.) There is no doubt that considerable economy is effected in its use for road watering; no injurious effect. It leaves a partially glazed surface on the roads, which is a great advantage in summer, because it binds and prevents the dust from blowing about; humidity is also maintained. The cost of road watering is reduced at least 50 per cent. All our streets are watered with salt water. Every dead end of the sewers is connected with the salt-water mains, so arranged that any sewer can be flushed by simply turning a sluice valve. All our public urinals are supplied with salt water. (1895.)

Coatham.—(Used for street watering and sewer flushing).—We have had our salt-water works in use since 1877 for street watering, flushing sewers, and urinals. With regard to street watering we find it far superior to fresh water, but in respect to urinals and sewer flushing we cannot say it is superior to fresh water, and it is used for this purpose on the score of economy. (1895.)

Falmouth.— (Used for street watering). — Our streets are all macadamised; I have observed that the salt water hardens the surface of the roads, and keeps the stones from rising. There is economy in the use of salt water, it will keep damp much longer, the roads will not require watering the third day, after being watered two days in succession. No objection to its use for flushing purposes. (1887.) Pure sea water has many advantages over fresh water, and is much to be preferred. It has the effect of causing an incrustation of the road surface, thus preventing wear and tear, and also reducing the quantity of dust. It also keeps damp for a much longer period than fresh water, therefore a less quantity will do, thereby effecting a considerable saving in team labour. Carts are filled from hydrants from point to point. (1895.)

Fleetwood.—(Used for street watering and public slaughterhouses).—The water we use is raised out of a well into a large tank, which contains a large quantity of salt; the well is in close proximity to the bed of the river or sea, and I consider it very effectual. (1887.) Salt water, such as ours, is much better for street watering than fresh water, for various reasons; at times when dust is most troublesome in the streets—it is shortly before rain begins to fall—the salt on the surface of streets becomes quite damp, and so prevents a large amount of dust being blown into the shops where doors cannot be closed against customers. (1895.)

Gosport and Alverstoke.—(Used for street watering and flushing purposes).—Sea water has been used here in an irregular kind of manner for years past. Last season salt water was used exclusively for road-watering and flushing purposes, with the very best possible results. It gave satisfaction to the inhabitants generally. When fresh water is used, our roads require watering nothing less than twice and sometimes three times each day, but, with salt water, once each day is sufficient. No complaints from tradespeople as to the tarnishing of metal goods, or of its being a destructive agent to boot leather or goods exposed for sale outside shops. Horse-keepers have great faith in salt water for keeping the legs of their cattle in good condition. In consequence of its antiseptic properties, I much prefer it. (1895.)

Great Yarmouth.—(Used for street watering and sewer flushing). — For seven years a flint and gravel road was watered with salt water. The road was about two miles in length, and, when watered with salt water, cost £70 a year less than it did with fresh water, and the road has never been in so good a state of repair. For three years five miles of gravel and flint road have, as an experiment, been watered with salt water, and the expenses of keeping this class of road are found to be quite 30 per cent. less than with fresh water. Thirty miles of these roads and five miles of granite roads are now watered with salt water. If salt water does a granite road no good, it certainly does it no harm. The sea water appears to gum the dust down on the road, and this must be got off in the early autumn. No bad result has been observed on a wood-paved street. The supposition that delicate articles exposed for sale are injuriously affected is a piece of "bosh" and a scarecrow. The town is now much more free from dust, and that has pleased the shopkeepers, who, one and all, would vote for salt water in preference to fresh. Street refuse does not become so offensive with sea water as with fresh water. The saving in road material and repairs, and in the cost of water distribution is very great, in consequence of the less quantity required, and the roads are much better watered. By flushing, the sewers can be kept quite clean, which is worth the cost of the whole job. (1887.) I know of no objection to the use of sea water for flushing sewers, watering streets, or for the supply of private houses. The admixture of sea water with sewage certainly does not cause any nuisance. The generosity with which the water is used jams more sewer gas out of the sewers, but does not create it. Sea water is quite as efficient as fresh water, and is, sanitarily, superior; its chlorine and ozone purify the sewers. The Water Company are the only people who do not like it. (1891.) On light gravel roads sea water does good, and saves 25 per cent. in repairs; on granite macadam roads, with heavy traffic, it does no harm. In watering, one load of sea water goes as far as three loads of fresh water. (1895.)

Grimsby.—(Used for street watering and sanitary purposes).—The use of salt water for watering roads repaired with granite has not in any way deteriorated them. During the last three seasons salt water has been used on the roads. I have not had a single complaint from any shop-keeper of damage caused to any goods exposed in shops; on the contrary, I have on several occasions heard tradesmen say that since salt water was adopted they have saved greatly through the absence of dust. I have never noticed that its use occasions any offensive decay of refuse, but I believe that the salt in the water would more tend to preserve refuse. Its use is decidedly most economical, as one load of salt water will last twice as long as one of fresh, and when it has dried, it leaves a thin crust of salt on the surface, which binds the dust and prevents its rising. (1887.) We have recently had a salt water supply laid down for sanitary purposes. (1895.)

Harwich.—(Used for street watering and sewer flushing).—After a short time a crust is formed on the surface, which effectually prevents dust from rising, even when the road is apparently dry, but when rain comes after a long spell of dry weather, this crust is turned into a viscid mud which is not very desirable. No complaints from tradesmen or others as to bad effect on delicate articles exposed for sale. It does not occasion any offensive decay of street refuse. It is both economical and efficient, one load of sea water doing as much good as two loads of fresh. (1887.) I have used sea water for these purposes for some fifteen years, and certainly prefer it to fresh water; particularly for street watering. (1895.)

Hastings.—(Used for street watering and sewer flushing).—No injurious effects on roads repaired with flint, gravel or broken granite. Have never heard complaints as to effect of salt water on delicate articles exposed in shops. Its use does not occasion any offensive decay of street refuse; is economical and efficient. Salt water has been supplied to private and public baths, schools, hotels, &c., for some time here, and is very satisfactory, both as regards efficiency and economy. (1887.) Sea water is quite as efficient as fresh for removing sewage matter. The objections to flushing sewers and urinals with salt water are considerable. I consider the use of salt water for any of the above purposes is, from a sanitary point of view, undesirable. The use of salt water for street watering and supplying private houses is decidedly objected to by the public. The outcome of the experiments was that in the long run 200 gallons of sea water were proved to keep down as much dust as it would require 300 gallons of fresh water to do, but the drawbacks in every other respect are so great, that if a town has plenty of fresh water, I should say decidedly not use sea water. I am decidedly of opinion that there is no saving, and a very considerable number of objections to it. (1891.) In practice it has been found that sea water is more efficacious in laying the dust than fresh water, but that the damage done to macadam roads by the salt is very considerable. The general opinion expressed was decidedly adverse to the use of salt water for street watering. For sewer flushing sea water is equally good as, and perhaps, where the gradients are good, better than, fresh water. The Corporation decided a few months ago, to entirely discontinue the use of sea water, in consequence of having thrown on their hands surface water reservoirs of the capacity of 41,000,000 gallons, and they are now using the water in these reservoirs for watering and flushing purposes. (Note.—*This is the only unfavourable opinion.*) (1895.)

Ilfracombe.—(Used for street watering and sewer flushing). — There is not the least doubt that it greatly assists to keep the surface of the street free from dust when used for the purpose of street watering; it is especially useful on level roads, or those with slight gradients; it is inclined to make steep gradients slippery when used on them. It is also most efficient for sewer flushing. The only place we can get it without laying down special plant is at the baths; the terms and difficulty of being able to get it when required led to its being abandoned. (1895.)

Littlehampton.—(Used for street watering). — The scheme was carried out here eight years ago, and has, up to the present, answered its purpose very well. The advantages of employing sea water instead of fresh water for road-watering purposes are two-fold; one load of the former equals nearly two of the latter, and there comes a great saving of the public water supply, generally at a time when there is the greatest demand for it. I have, however, experienced this one disadvantage: late in the autumn, when thoroughfares are generally damp, the latent saline properties of the sea water on the macadamised road surfaces show themselves in the form of a slime on the road surfaces, but a few good scouring rains, as a rule, remove it in time. (1895.)

Londonderry.—(Used for street watering).—In my opinion it is preferable to using the City water supply. I have never heard of any complaints of damage to goods, nor carriage owners, nor in any other form through use of salt water. (1888.) Find it much superior, both for street watering effect and as regards economy. (1896.)

Plymouth.—(Used for street watering). — We use salt water indiscriminately on all macadam roads. Everyone likes it. It forms an incrustation on the road, which preserves the face and retains the moisture. One load of salt water goes further than two of fresh. Never heard any complaint as to effect on delicate articles exposed in shops. It does not occasion any offensive decay of street refuse, as it is a disinfectant. (1887.) It is used very considerably during the very dry and hot part of the summer. It is superior to ordinary fresh water from the fact that the roads do not require watering so frequently when salt water is used. This remark applies both to macadam and wood-paved roads. (1895.)

Portsmouth.—(Used for street watering and public baths).—It has a very good effect on flint or gravel roads; it binds them; not so good on roads repaired with broken granite. Has no effect on delicate articles exposed in shops, and does not occasion any offensive decay of street refuse. Its use is both economical and efficient: one load of salt water equals three load of fresh in efficiency. (1887.) I believe salt water to be far more efficient than fresh; more particularly this is seen in the flushing of urinals and the watering of streets; but the good effect in the flushing of sewers may not be any less because it is not so easily seen. Salt water appears more efficient than fresh water; being of greater specific gravity, it, so to speak, carries the sewage on its back. The public and shopkeepers favour the street watering with salt water. (1891.) I am most favourable to the use of sea water for road watering; it is no doubt more economical than fresh. It is well known that sea water contains a large amount of salts of a highly deliquescent nature, takes longer to evaporate than fresh water, and the streets will keep moist for a longer period than when watered with an equal quantity of fresh water. It was at first thought by tradespeople that their goods would be injured by the use of salt water, but I have not received one single complaint since the adoption of the scheme. As watering the roads with sea water is so economical, I have strongly recommended my committee to extend the scheme to the whole of Southsea. (1895.)

Redcar.—(Used for street watering and sewer flushing).—Sea water is found as efficient as fresh water; no objections arise from its use, and its admixture with sewage in the sewers does not cause any nuisance. Is in favour with the shopkeepers and public generally; the ratepayers consider the salt water scheme a great boon. (1891.) We find it to be more effective for laying dust; it lasts twice as long as fresh water. (1895.)

Ryde.—(Used for street watering).—On roads repaired with flint or gravel it causes a crust to form, and keeps damp longer than fresh. We have used salt water for street watering about 35 years; its use is economical and efficient; no complaints from shopkeepers. (1887.) We find it superior to fresh; but on our steep roads we are obliged to use fresh water for the second coat, otherwise the road would become too slippery. (1895.)

Shoreham (New).—(Used for street watering and sewer flushing).—It binds the road and causes a hard incrustation to come on the surface, which is very beneficial to vehicular traffic. Never had any complaint as to its being injurious to delicate articles exposed in shops. Its use is very economical; once watering with salt water is equal to twice with fresh water. (1887.) It is, no doubt, superior to fresh water for watering roads, as it does not evaporate so quickly, and also, I think, improves their surface. For flushing purposes it is also well adapted, from its disinfecting proper ties. (1895.)

South Shields.—(Used for street watering).—A beneficial effect on the road, binding it together. Its use effects a great saving in horse hire and time. (1887.) The roads certainly keep moist for a very much longer time than when watered by fresh water, and also the sea water has a binding effect on the surface of the road which is not so prone to disintegrate. The roads do not give off a disagreeable odour; sea water tends to prevent decomposition rather than to increase it. (1891.) Sea water is very superior to fresh water for watering streets and roads, the moisture lasts so very much longer. I have known our roads to be dusty an hour after watering with fresh water, while roads watered on the Saturday with sea water retained moisture till the Monday, and did not need watering till the next day; thus the saving in horse hire is immense. (1895.)

Stockton-on-Tees.—(Used for street watering).—No prejudicial effect on roads. Salt water produces a freshness quite unknown in fresh water, and keeps moist for a longer period. It is quite adapted for macadamised roads, and can be used with advantage on wood. As regards causing offensive decay of street refuse, sea water is preferable to fresh water. As the Corporation commands a very large interest in the supply of water for domestic purposes, it has not been worth while for them to carry out the scheme for the supply of sea water. (1887.)

Torquay.—(Used for street watering).—We use sea water to some extent; the effect is not very marked in any way. (1887.) We use sea water upon our roads very largely during the summer. I have found the use of sea water much more economical than fresh water, and more efficient. It has been in use for nearly fifteen years. We get no complaints as to its being used. (1895.)

Tynemouth.—(Used for street watering, sewer flushing, and public baths).—Watering macadam roads with salt water cakes the surface and binds the top metal, improving the condition of the roads to a marked extent. No particular effect on wood paving noticed. A jeweller states that its use casues no noticeable effect on his goods. Have not noticed any offensive result from the use of salt water in streets. Its use is both economical and efficient; one watering with salt water is worth three with fresh water. (1887.) No objections arise from the use of sea water. It is as efficient as fresh water for flushing sewers and carrying sewage matter. With regard to watering the streets, we consider the moisture is retained longer than when fresh water is used. (1891.) As regards economy, we find the sea water to be superior to fresh. With respect to efficiency, I cannot say the sea water is in any way superior to fresh water for the flushing of sewers, but for street watering it certainly is superior. A thin crust of salt is formed upon the roadways, which binds the dust, and the effects of the salt water are consequently more lasting than those of fresh. (1895.)

Weymouth.—(Used for street watering).—The salt forms a crust on the road surface, which keeps the dust from rising. I have never received complaints. The shopkeepers prefer the use of salt water, as it is more effective in keeping down the dust. No nuisance of offensive decay of street refuse is caused by the use of salt water. It is more economical to use salt water. (1887.)

Summary.—The advantages of a constant supply of sea water to London may be thus shortly summarised:—

1. There would be less dust and smell, and more cleanliness in the streets.
2. Watering would be less frequent, and more efficient.
3. The road surface would be more durable, requiring fewer repairs.
4. The sewers would be less offensive.
5. The cost to the ratepayers would be probably a quarter, or even a third less than the present cost of water for public purposes.
6. Hospitals and schools would be provided with additional means to health.
7. Every house could be furnished with its own sea bath.
8. The saving of fresh water would be very great, practically adding 25 per cent. to the present supply.

DISCUSSION.

The CHAIRMAN said they were much indebted to Mr. Grierson for bringing forward this very important subject. The experiment of saline watering was tried in London some 15 years ago, when Mr. Cooper patented a method of watering streets with a solution of chlorides of sodium and calcium, claiming to get by their use a liquid which would not readily dry, and which would be so much more economical with regard to labour, as to fully repay the cost of the chemicals used. The plan was tried during one summer by the Vestry of Paddington, and he took the opportunity of inspecting the result. It did precisely what had been described by the officials of the various towns referred to ; it practically abolished dust, and the shopkeepers of the Harrow-road were delighted to find that their goods were no longer covered with dust. When there was any moisture in the air, the streets did not dry ; and when they became dry, instead of the surface of the macadam becoming dusty, it caked, and made an admirable smooth surface for wheels. The experiment was not pursued after the period for which the first contract was made, but, he believed, its abandonment was not owing to any demerits, but depended on certain legal difficulties connected with the property in the patent. Any chemist would say that sea water could not have any noxious effect. Nothing was said in the paper as to the prospect of this scheme being carried into effect. He should also like to know whether the £450,000 mentioned covered merely the laying of the mains shown on the diagrams, and whether any provision had been made for the vast expense which he should imagine would be required for laying fresh service pipes to a large number of houses. On that point householders would have to remember that until the Acts under which they were at present taxed by the water companies were modified, they would have to pay just as much for fresh water as before, even though they did not use it so much, except in those cases where they could get rid of the special charge for baths.

Mr. LEWIS ISAACS said such a scheme as this could not fail to interest him very greatly, and he had sent Mr. Grierson an official letter from the district under his charge, asking for further particulars, which had been answered by the engineer to the scheme very fully. Of course he was anxious to know the position, size, &c., of the mains proposed to be laid in the Holborn district, and was informed they were to be 12-inch pipes, laid under the carriageway at a depth of 2 feet 6 inches. This point was very important, remembering the difficulties which occurred last year in many districts from the freezing of the water mains, much to the injury of the reputation of some of the water companies ; and this was enhanced when in the summer, which was exceptionally hot, the water supply was in certain places very deficient. He congratulated the author on the comfort he had afforded them by the promise that a large quantity of water now used for non-domestic purposes would be set free and made available for household consumption. It had often struck him as a great reproach on this scientific age that we should so long continue the wasteful system of going to great expense in filtering, and rendering fit for drinking purposes, every drop of water which was used to water the streets and flush the drains. But he should have been glad if Mr. Grierson could have spoken a little more positively as to the saving which might be effected in this direction. The price paid for water for municipal purposes was, in some cases, at any rate, not 9d., but 6d. per 1,000 gallons ; and he should have liked a more definite statement than a mere opinion that the water supplied under this scheme for municipal purposes would not, at any rate, cost more than that now supplied. Looking to the fact that the water was taken from the sea, and that there were only two reservoirs in a length of about 60 miles, and one pumping station, he should have thought the water could be brought to London at a cost which would enable the projectors to beat the water companies completely out of the market. He should not have been surprised to hear that the cost need not be more than half. He could not speak from experience as to the suitability of sea water for road watering, but he had seen some of the towns mentioned, and he must say the *volte face* of the authorities at Hastings within a few years was very surprising, and he thought there must be something behind which was not disclosed. He had seen the application of salt water for this purpose in four or five places, and came to the conclusion that, in the main, Mr. Grierson was right. Sea water had a peculiar effect on macadam dust, forming a cake, which, he would not say was quite so nice for draught as the result of watering by the ordinary process, but undoubtedly the effect was much more durable ; it was probably within the mark to say it lasted twice as long, but he should hardly think three times. He hoped Mr. Grierson was right in saying that its application to sewage matter would be as beneficial as he stated, but he had heard doubts expressed on this point. It struck him that the salt must have a beneficial effect, though he had not sufficient chemical knowledge to speak positively, and if it could be obtained cheaply and municipal engineers had the opportunity of turning on a hydrant wherever they liked, they ought to be able to effect a great change in the condition of the London sewers. He did not know whether sea water would be as useful in extinguishing fires as fresh water. Londoners were now so alive to any hing beneficial in a hygienic point of view, and were so willing to spend money in luxuries, that he had little doubt of the financial success of the scheme if the pipes were once laid down. He should certainly be one of the earliest customers, and Mr. Weaver, surveyor to the Kensington district, who was a great swimmer, would, he was sure, be another. If they could be taken as fair samples of the average Londoner, there would be a good prospect of success. He might say unofficially, that so far as his own district was concerned he should offer every possible facility to the scheme.

Mr. WEAVER said, looking at the question as a private individual, he thought it was quite time that London should have sea water brought to it, as it was only 50 miles from the cost. Whether it would ead to any monetary advantage was a difficult question. They had to pay for water according to the rateable value, his contribution being £18 or £20 a year, and if he could see his way to reducing it to £10 he should yearn for the sea water to come as quickly as possible, but he was afraid it would not have that effect. He had learned that the largest mains in his district were to be 30 in., diminishing to 12 in. and 9 in., and he must say he doubted whether 30 in. would be large enough if there were a large demand. As a road surveyor he remembered Mr. Cooper's experiment being tried in the southern division of his district, that gentleman having the contract for one summer. At that time the Brompton-road was laid in macadam, and the conclusion which he and his subordinates arrived at was that the salt had a very injurious effect on the macadam. It might cake the mud together, but on his roads there was very little mud left, and the effect it had was to make the macadam loose. It was consequently abandoned after the first year, and he thought it would be well for surveyors to make further inquiries on this point. He knew that at Brighton the use of sea water was given up, not so much for the effect on the roads as for the objections of the public. The shopkeepers, especially the silversmiths, objected to it, and ladies complained of the injury to their dresses. He learned this from Mr. May, the borough engineer. Of course in London the greater of the main roads were wood or asphalte, and on these surfaces, no doubt, sea water would be preferable, as it kept the road damp much longer. In Kensington they only paid 6d. per 1,000 for water.

Col. Allan Cunningham said the most interesting aspect of the question to him was the great saving which would be effected in the use of fresh water. The time was rapidly approaching when potable water would be a most valuable commodity as the population in all large towns kept on growing, and the means of getting fresh water did not keep pace with it, or could only be kept up by a vast expenditure; anything which could be done to husband it was most important. There was an enormous waste in filtering water until it would pass a chemical analysis as being fit for drinking, and then throwing it down the sewers. There had been a great deal of evidence from various towns as to the advantages of using sea water, but it ought, probably, to be discounted to some extent, bearing in mind that all these towns were on the sea coast, where they would get sea water cheap, and naturally were inclined to speak strongly in favour of it. Some disadvantages had already been referred to; a minor objection would be that in frosty weather they would feel it in their boots, and it would probably be a good thing for cobblers. Brine did not freeze very quickly, and therefore formed a much colder liquid than fresh water at the freezing point, and would be more disagreeable if one's boots got sodden. For the same reason, it would affect the feet of horses and dogs, and probably cab-ranks, where horses were kept standing, would have to be raised a little, as a matter of humanity. It was important to know how far the intake was from any possible pollution by sewage. It would also be a very expensive matter to introduce an entirely new set of fittings into houses for the use of salt water, and he feared there would not be much demand from the public for a long time, except from hotels, clubs, baths, and very wealthy people.

Mr. W. H. Garbutt (Vestry Clerk of Marylebone) suggested that it would be well to have some information as to the possible effect of salt water on ordinary fittings, and whether the iron mains would not soon be rendered worthless. He had heard that some of the cast-iron supports to piers at the seaside had been seriously injured in the course of a few years by the action of salt water.

Mr. Macintyre, as the engineer to the scheme, said he would answer some of the questions which had been raised. The mains were designed to provide 10,000,000 gallons per day, but if the demand were found to exceed that quantity, additional ones could be laid. At present the main for the intake was 36 inches. About Dorking it was reduced to 32 in. as far as the reservoir at Epsom, and from there to London, the fall being more rapid, it would be 30 in. Salt water was more efficient in extinguishing fires than fresh. A chimney on fire could often be extinguished by putting salt on the fire, the effect being an evolution of chlorine, which choked a fire at once. Care had been taken to select a spot for the intake, at least a mile distant from any source of pollution. It was suggested that salt water might effect horses feet and people's boots in winter, but as a matter of fact the streets were not watered in winter. He was glad to find that Major Isaacs approved of the details supplied him as to the depth of the pipes; all these details had been carefully considered, and with regard to them they were desirous of consulting the authorities of the different districts as far as possible. The present idea was to erect standards at all the principal cross streets so that the watering of the cross streets could be conveniently carried out to the distance of about half a mile from the main on each side. The castings which had been referred to were exposed to the sea water and air alternately, which was very trying to either iron or wood. These mains would be constantly full, the velocity of flow being 160 ft. a minute. There would not be the trying alternation of wet and dry; but, of course, they would wear out in time like other pipes; all that had been taken into consideration. The estimate was ample, being founded on actual tenders from eminent contractors for the different classes of work. There would be 18 or 19 miles of mains in London, sufficient to introduce the water to all the principal parts. If the use of sea water were found advantageous, no doubt other mains would be asked for, and they would be extended by agreement with the various authorities concerned.

Mr. GRIERSON said it was very encouraging to hear it suggested that a 30-inch main would not be large enough to supply the demand in Kensington. His statement as to the average price of water for municipal purpose had been called in question, but his figure was based on official returns. He was aware that in some places, and for some special purposes, it was 6d., but in other cases it went as high as 1s. 3d., and the average was within a small fraction of 9d. With regard to the effect on macadam roads, he would refer to the report from Barrow-in-Furness, which dealt with that very point. With regard to the effect on horses' feet, of course there would be no salt water in the streets in time of frost, and the surveyor of Gosport, where sea water had been used many years, said horsekeepers had great faith in salt water for keeping the legs of their cattle in good condition. Of course that applied to the summer.

The CHAIRMAN then proposed a vote of thanks to Mr. Grierson, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

SALT INDUSTRY OF VENEZUELA.

Salt is one of the principal products of Venezuela, and a considerable trade is carried on in its production and exportation. The salt-pans are situated along the shore, and were formerly in charge of the Government of the several States; but in the year 1873 they conceded their rights over them to the Federal Government for a certain annual sum in proportion to the amount produced by each. The Government administered the works for a time with its own *employés*, but afterwards made contracts with private individuals for carrying on the same, with the understanding that they should pay the sum of 4,500,000 bolivars (about £170,000) for each six years. This system was abandoned as unprofitable, and a superintendent of works was named, who had to deliver to the Government 50 per cent. of the money received, retaining the balance for his expenses and profit. In March, 1893, the Bank of Venezuela took charge of the industry as general administrator for the Government, receiving as a commission 10 per cent. of the net proceeds. The United States Secretary of Legation at Caracas says that the principal salt works of the Republic are situated in the sections of Nueva Esparta (Island of Margarita), Cumanâ, Barcelona, Maracaibo, and Coro. To the islands of Nueva Esparta belong the most important works at Coche, which are the largest, and at Pampatar. The Coche works are on the island of that name, which was formerly famous for its pearl fisheries. The pans measure 1,544 metres in length, by 820 metres in breadth, and are one metre in depth. They are separated from the sea by a strip of land 800 metres broad, crossed by a channel for the introduction of sea water. In January and February the crystallisation begins, and in March and April the collecting of the salt takes place, the crust then being about 10 centimetres in thickness. This work lasts for five or six months. At Pampatar the pans measure 2,000 by 600 metres, but the product is inferior to that of Coche, and the pans are not in operation. The works in the section of Cumana, the second of importance, are at Araya, and are very large, measuring about five kilometres (3·16 miles) in length by one kilometre in breadth, being a natural depression, which has been worked since the discovery of the continent, and, it appears, by the Indians in pre-Columbian times. The Spaniards had several fortifications here, which were attacked on various occasions by the English and Dutch. The salt is rather dark in colour, but is reputed to be of a very good quality. A short distance from Carupano there are the salt works of Areo, producing a salt of fine quality. This pan has, however, been abandoned, on account of its small production. On the coast of Barcelona there are several works of little importance, the larger ones being at Unare and Casanare. In the section of Maracaibo there are a great number of pans, some of them being private property, the owners of which are obliged to submit to the conditions fixed by the Government for the sale of salt. In the State of Falcon are to be mentioned the works of Los Tagues, Mitare, and El Guaranao, while at many points the salt is not even collected. Finally, in the State of Carabobo there are several places where salt is collected, Goigoara producing a very white and good article that has occasionally been exported. The annual production of salt amounts to about 18,000,000 kilogrammes. Salt is sold at the several works through a permit issued by the Custom-houses, at the rate of about one halfpenny for every two pounds, when for home consumption, and at a very much lower rate when for export, which, however, takes place only to Colombia. The whole population of the Republic of Venezuela being about 2,500,000, and the annual production of salt, as shown above, to be about 18,000,000 kilogrammes, it results that the consumption per head is nearly 7 kilogrammes per annum. It is not expected that any notable exportation of salt will ever take place from Venezuela, and if the population does not increase more rapidly, and better ways of communication are not established, or industries introduced which require large quantities of salt, the amount of 18,000,000 kilogrammes per annum, as the amount consumed, will hardly increase.

HYGIENIC EXHIBITION AT WARSAW.

The United States Consul at Warsaw says that the second Hygienic Exhibition of Warsaw will be held in that city during the present year. It will be opened on the 15th May, and will close on the 15th July. The first hygienic exhibition in Poland was held in the year 1887, and judging from the success which the undertaking met with at that time, and taking into consideration the interest shown at present among medical men and the public at large in hygiene, the usefulness of the new exhibition is stated to be assured. There are nine committees at work to whom have been assigned the following subjects:—(1) Air, water, light; food in general, and articles connected with the above; also kitchen utensils, paints, wall-paper, and poisonous vegetables. (2) The question of sterilisation; also the utensils used for the culture of bacilli, showing exhaustively the method of ascertaining their presence and the means for their destruction. (3) Human dwellings in general, past and present, and the latest improvement in hygienic building. (4) The hygienic mode of caring for children; construction of school-houses, all systems of school education, and school-rooms and furniture. (5) The hygiene of industry; the hygienic conditions prevailing in the homes of labourers, shops, and factories; also food, and drink, and vital statistics. (6) The history and statistics of hygiene and the modern hospitals of the world. (7) The literature and history of pharmacy, patent medicines, furniture, medical instruments, and all pharmaceutical utensils. (8) Statistical plans, diagrams, drawings, and all printed matter on the subject of hygiene, meteorology, geology, hydrography, and anthropology, in all their detail, and all sciences connected therewith. (9) The manner of living, dwellings, &c., of all classes of the population from a sanitary point of view. Awards of gold, silver, and bronze medals will be made, and also diplomas and letters of honour.

Obituary.

Rev. William Rogers.—The Rev. William Rogers, Rector of Bishopsgate, who died on Sunday, 19th inst., was for many years a member of the Society of Arts. He was a member of the Council in 1865 and 1869, and a Vice-President from 1870 to 1875. In 1845 he was appointed to the incumbency of St. Thomas, Charterhouse, a position which he held for eighteen years. The district was the headquarters of costermongers, and on April 1, 1857, he read an important paper before the Society on the "Trade, Habits, and Education of the Street Hawkers of London," the late Earl of Shaftesbury being in the chair. In 1863 he was presented the rectory of St. Botolph, Bishopsgate, which he held till his death. His life was largely devoted to the improvement of education. He was one of the founders of the Cowper-street Schools, and an influential Governor of Dulwich School.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

January 29.—"Standards of Light." By W. J. Dibdin, F.C.S. Captain W. de W. Abney, C.B., F.R.S., will preside.

February 5.—"The Mexican Drainage Canal." By Frederick Henry Cheesewright, M.Inst.C.E.

February 12.—"Water Purification by means of Iron." By F. A. Anderson. Sir Douglas Galton, K.C.B., F.R.S., will preside.

February 19.—"Report of the Royal Commission on Secondary Education." By H. Macan. Sir Owen Roberts, M.A., will preside.

February 26.—"The Standard of Musical Pitch." By A. J. Hipkins.

Papers for evenings, the dates of which are not yet fixed:—

"Dairy Produce." By George Barham.

"Some Native Irish Industries." By Prof. Haddon.

"Orthochromatic Photography." By Capt. W. de W. Abney, C.B., F.R.S.

"High Explosives and Smokeless Powders." By Hudson Maxim.

"Early English Organ Writers." By Burnham Horner.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

February 13, at 4.30.—"Punjab Irrigation—Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab. Lieut.-General R. Strachey, R.E., C.S.I., F.R.S., will preside.

February 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. Tripp, formerly of Sumatra. The Marquis of Lorne, K.T., M.P., will preside.

March 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. Glass, C.I.E., Chief Engineer, Dept. Public Works, Bengal. Sir Charles H. T. Crosthwaite, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

March 26, at 8.30.—"Kashmir: its People and its Products." By Walter R. Lawrence, I.C.S., C.I.E.

April 23, at 4.30.—"The Deserted City of Vijianagar." By Captain Charles Rolleston.

May 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. Christison.

The meetings of February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

FEBRUARY 4.—"The Garden in Relation to the House." By F. INIGO THOMAS.

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S. WALTER CRANE, R.I., will preside.

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

JANUARY 28.—"Stamboul: Old and New." By RICHARD DAVEY.

FEBRUARY 18.—"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL (General Electric Company, U.S.A.).

MARCH 3.—"The Commercial Prospects of English East Africa, and British Central Africa." By G. SCOTT ELLIOT. SIR JAMES CRICHTON BROWNE will preside.

APRIL 21.—"Madagascar." By CAPTAIN PASFIELD OLIVER.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.

JANUARY 27.—LECTURE II.—*The Construction of the Transformer.*—The core—Sheet-iron stampings—Building the core—Prevention of core losses—Selection of iron—The coils—Coil winding—Insulation of coils and core—The case—Ventilation and surface radiation—The terminals—Primary and secondary fuses and switches—Sizes and forms of transformers in practice—Open and closed circuit transformers.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.

March 9, 16, and Tuesday, March 24.

⁂ It has been found necessary to alter the date of the third lecture to Tuesday, 24th March, instead of Monday, 23rd. The first two lectures will be delivered on Mondays.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 27 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. A. Fleming, "Alternate Current Transformers." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. James N. Miller, "An Experimental Crank Apparatus, with Experiments on same." 2. Mr. George Thomson, "Some Contributions to Instrumental Arithmetic."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. A. Fitzgerald, "The First Crossing of the Southern Alps of New Zealand."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. T. Charters White, "Photo-Micrography."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Professor W. B. Richmond, "The Decoration of St. Paul's—How it came About."

TUESDAY, JAN. 28 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Richard Davey, "Stamboul: Old and New."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Coverings of Plants and Animals: its Structure and Functions." (Lecture III.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 12, Hanover-square, W., 8 p.m. 1. Mr. J. H. Agar Baugh, "Dr. Rudolph's Method of Lens Testing, and some of his results." 2. Mr. Fred. Iles, "Steoromicrographs, with New Colour-tone Effects."

Colonial Institute, Northumberland-avenue, W.C., 4½ p.m. Rev. W. K. R. Bedford, "Malta and the Maltese Race."

WEDNESDAY, JAN. 29 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. J. Dibdin, "Standards of Light."

United Service Institution, Whitehall, S.W., 3 p.m. Commander W. Caborne, "Our Seaborne Commerce and Mercantile Marine."

British Astronomical, University College, W.C., 5 p.m.

THURSDAY, JAN. 30 ... Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. J. Powell, "Mosaics: Ancient and Modern."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Philip H. Wickstead, "Dante." (Lecture III.)

Civil and Mechanical Engineers, 45, Charing-cross, S.W., 7 p.m. Mr. W. M. Binny, "Hot Water Heating."

Mechanical Engineers, 25, Great George-street, W., 7½ p.m. 1. Professors Barr and Stroud, "Telemeters and Range-Finders for Naval and other Purposes." 2. Lt.-Col. Thomas English, "Calculation of Horse-power for Marine Propulsion."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Dr. Lindsay Johnson, "Nature's Method of Correcting Astigmatism, &c."

Imperial Institute, South Kensington, S.W., 5 p.m. Mr. W. Savile Kent, "The Fish and Fisheries of Australia."

FRIDAY, JAN. 31 ... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Sidney Lee, "National Biography."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Mr. W. H. Patchell, "Notes on Steam Superheating."

SATURDAY, FEB. 1 ... Royal Institution, Albermarle-street, W., 3 p.m. Prof. Hubert Parry, "Realism and Idealism in Musical Art." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 27th inst., the second lecture of the course on "Alternate Current Transformers," was delivered by Dr. J. A. Fleming, F.R.S.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Tuesday, 28th inst., at 4.30 p.m. Present:—Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., in the chair; Lionel R. Ashburner, C.S.I., Jervoise Athelstane Baines, C.S.I., Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., E. C. Danvers, Sir Juland Danvers, K.C.S.I., Major-General Sir Frederick Goldsmid, K.C.S.I., C.B., W. S. Seton-Karr, W. Lee-Warner, C.S.I., T. H. Thornton, C.S.I., D.C.L., Arthur N. Wollaston, C.I.E., W. Martin Wood, with Henry B. Wheatley, Assistant-Secretary, and S. Digby (Secretary of the Section).

FOREIGN & COLONIAL SECTION.

Tuesday evening, January 28th; Major G. E. W. Malet in the chair. The paper read was "Stamboul: Old and New," by Richard Davey.

The report of the paper and discussion will be printed in a future number of the *Journal.*

Proceedings of the Society.

EIGHTH ORDINARY MEETING.

Wednesday, Jan. 29, 1896; Capt. W. de W. Abney, C.B., F.R.S., Member of the ouncil, in the chair.

The following candidates were proposed for election as members of the Society:—

Banerjee, Gopal Chandra, Cawnpore, N.W.P., India.
Biddulph, C. E., Secunderabad, India.
Hartley, Harold, 63, New-park-road, Streatham-hill, S.W.
Hawthorne, James G., 41, East India Dock-road, E.
Scott, James George, C.I.E., care of R. F. Scott, St. John's College, Cambridge.
Terry, Stephen Harding, 17, Victoria-street, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Arnot, J. Melrose, Bally, Uttapara, near Calcutta, India.
Burrell, Frederick John, St. Mary's-house, Thetford, Norfolk.
Butler, Matthew Joseph, Bay of Quinte Railway, Deseronto, Ontario.
Clerk, Dugald, 13, Temple-street, Birmingham.
Davies, Theophilus Harris, J.P., Sundown, Hesketh-park, Southport.
Dodd, John, J.P., The Hollies, Werneth, Oldham.
Dunn, Edmund Richard, 90, Queen-street, Ramsgate.
Evans, Richardson, 1, Camp-view, Wimbledon-common.
Gerrans, Henry Tresawna, M.A., Worcester-college, Oxford.
Ghasvala, B. E., Government Laboratory, Byculla, Bombay, India.
Hansford, Charles, 3, Alexandra-terrace, Dorchester.
Holdich, Colonel Thomas Hungerford, R.E., C.B., The Park, Simla, India.
Holmes, James G., Thorne-lodge, Oakfield-grove, Clifton, Bristol.
Hutchinson, J. T., Aden-house, Bury, Lancashire.
Mulliner, Herbert H., Pneumatic Tyre Company, Limited, 14, Regent-street, S.W.
Purdon, Henry Atwell, Aguilas, Provincia de Murcia, Spain.
Swinburne, James, 66, Victoria-street, S.W.
Vernon, Hon. Forbes George, 39, Victoria-street, Westminster, S.W.
Wyman, John Sanderson, 22, Nottingham-place, W.
Young, Edwin, 2, Gordon-terrace, Hamilton-road, Brighton, and County-hall, Lewes, Sussex.

The paper read was—

THE STANDARDS OF LIGHT.

By W. J. Dibdin, F.I.C., F.C.S., &c.

On the 21st December, 1888, I had the honour of reading before the Society of Arts a paper on the subject of the standards of light, in which paper I discussed the position of the question as it then stood, summing up briefly the results of the various inquiries conducted from time to time by authorities in this country and on the continent. The position in which the question had then arrived may be shortly put thus:—The authorities of the Board of Trade—the controlling authorities for gas testing purposes in London—the gas interest generally, as represented by the Gas Institute and the British Association, had all joined in one condemnation of the existing candle, and in demanding an alteration; and, with one exception, that such alteration should consist in the adoption of Mr. Harcourt's pentane air-gas flame.*

After careful consideration of these facts, an impartial observer would probably have drawn the conclusion that the time was then ripe for a change, and that legislation would follow without delay. Unfortunately, other counsels prevailed, and we have now arrived at a period seven years later, without the attainment of the alteration so earnestly desired and looked forward to by all those who have made the subject one of special study, and who daily experience the discomfort of having their best endeavours marred by the imperfect nature of the standard employed, as by Act of Parliament they are compelled to use the long since discredited candle instead of one of the known reliable substitutes.

In view of the uncertainty prevailing in the minds of the Parliamentary experts of the Board of Trade, rather than in that of their scientific advisers, a further series of inquiries was instituted by a committee appointed by that Board on the 23rd December, 1891. The committee was composed of representatives of the two controlling authorities for gas testing in London, viz., the City and the London County Council; the three large gas companies, viz., the Gas Light and Coke, the South Metropolitan, and the Commercial Gas Companies; the gas referees; and two independent representatives of the Board of Trade. In connection with the appointment of this committee, it is to be noted that it was not until the South Metropolitan Gas Company came forward with an offer to meet the expenses of the committee that it was constituted, as neither the Board of Trade nor the controlling authorities had funds at their disposal for that purpose. Probably this action on the part of a commercial company forms a stronger argument in favour of the long-desired alteration than can be put into words.

After three years of most patient work, during which all the points were carefully and exhaustively reviewed, that committee issued its report, and the question has consequently taken one more step forward, although, as a matter of fact, the scientific result is, to all intents and purposes, in much the same position, viz., the candles are (if possible) still more hopelessly condemned, and one of the proposed more reliable substitutes recommended for adoption in their place. Mr. Harcourt's pentane standard has again been vindicated, as a reliable and exact standard; and for practical use in gas-testing the pentane - Argand, proposed by myself in 1886, has been chosen as a suitable substitute for candles in daily work.

It is to be hoped that the unanimous report of a committee, expressly selected so as to include representatives of all the various interests concerned, will result in speedy legislation, and thus at last put an end to a controversy which has been one of the vexed questions of the day for over 20 years. In the meantime, it will be desirable that the essential features of this last official report should be fully discussed, and, with that view, I venture to submit the following summarisd account of the work of the committee, as given in the report. The various points may be considered in the following order:—

1. Unsatisfactory standard furnished by the flame of a sperm candle, by reason of the amount of light which it affords varying over a wide range, under conditions as to the manufacture of the candle, as to its mode of use, and as to the adventitious circumstances attending its use, which, as a whole, it is not possible to regulate and define.

2. The advisability of continuing to express, as heretofore, in official documents and reports, the quantity of light yielded by coal-gas burned under specified conditions, in terms of candle-light, the actual comparison, however, being made between the gas light and some well-defined and constant light ascertained to be equal in quantity to, or a definite multiple of, the average light given by the standard sperm candle.

3. The conclusion that, in the present state of experience and knowledge, the source of light to be used as a standard by gas-testers generally must be produced by the process of combustion, and be in the nature of a flame.

4. That the one-candle light flame proposed by Mr. A. Vernon Harcourt does constitute a very exact standard, capable of being reproduced at any time without variation of illuminative value; and that this flame is a

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* Vol. xxxvi. p. 72.

true representative of the average light furnished by the sperm candle flame constituting the present standard.

5. Inasmuch, however, as there is a practical advantage in comparing directly the light of such a coal-gas flame as is usually tested (being that is, of about a 16-candle light value), with a light approximating somewhat in value thereto, the committee submitted to careful examination the flame of the 10-candle light pentane-Argand proposed by the author as a standard in 1886. This flame is produced by burning a mixture of air and pentane vapour from a suitable Argand burner, provided with an opaque screen, by which the light from the upper portion of the flame is cut off. The screen being set at a definite height, the luminosity of this portion of the flame remains constant, even under considerable variations, owing to a compensating action affecting the lower or exposed portion of the flame.

6. The amount of light emitted by the lower portion of the flame is substantially equal to ten times the average light of a standard sperm candle flame, or to ten times the light of Mr. Harcourt's one-candle light pentane air-gas flame.

7. That any number of the Dibdin Argand burners may be produced, and may be depended upon to furnish a flame giving, when duly screened at the top, ten times the average amount of light given by a sperm candle.

8. Then follows the recommendation that the pentane-air flame furnished by this pentane-argand burner be accepted as giving the light of ten standard candles, and that it be authorised and prescribed for official use in testing the illuminating power of the gas supplied by the London gas companies.

9. With a view to making some provision for future possible improvements and requirements, the committee further recommend that the gas referees be authorised, should they at any time see fit, to approve and certify for gas-testing any other flame based upon the ten-candle standard defined above, which they may consider suitable for the purpose, whether produced in a like or unlike way, and having the same or a different multiple value; such other flame, however, not to be used for gas testing unless approved by the Board of Trade, and unless the gas companies give their consent to its adoption as a standard.

10. The committee then proceeded to recommend that the illuminating power of coal gas shall continue to be recorded as heretofore, in terms of the light given by a specified number of cubic feet (to wit, 5 cubic feet) burnt per hour from the standard London argand burner, but that the requirement that the gas shall actually be consumed at that rate be rescinded, so as to allow the gas referees to sanction a mode of testing in which the gas shall be burned at whatever rate is found requisite, in order that it may give a light equal to that of the prescribed number of candles, and in which the illuminative value of the gas shall be calculated as being inversely as the rate at which such gas had been burned during the testing, so as to give this amount of light.

The chief error in the amount of light emitted by a candle is due to variations in the character of the wick employed. Exhaustive experiments have shown that the number and size of the threads in the wick, the closeness of the plaiting of the strands, the pull on each strand during plaiting, the previous cleaning of the cotton used, the treatment of the wick by the manufacturer, and the extent to which the wick is stretched when set in the candle-mould by the workman, are all factors of considerable importance, affecting the light which a candle gives. Various other conditions also affect the result, such as the length of time it has been burning, whether the "cup" of the candle is dry or contains melted sperm, the roughness or smoothness of the wick, the curvature of the wick, &c. Added to these difficulties, we have the impossibility of making candles which will burn 120 grains an hour. The gas referees' instructions allow the use of a candle burning within 5 per cent. of the prescribed amount, but even this does not overcome the trouble, as candles very frequently burn outside these limits, departures of even 10 to 20 per cent. being by no means unknown.

In Germany sperm candles have been abandoned for paraffin candles, made under the supervision of the authorities, and specially marked; but the same troubles are experienced as with the sperm candles.

The committee, therefore, unhesitatingly recommended the abolitlon of the candle as a standard of light, and the introduction of some more reliable unit.

The decision of the committee respecting the continuation of the practice of stating the quantity of light in terms of the candle will doubtless recommend itself to all persons interested in the question. The unit thus expressed is one which is well understood generally, and whilst being in itself convenient, represents a quantity of light which is practically the smallest used in daily life. It is only exceptional radiants, such as the arc light, concentrated by a lens, that emit larger multiples of this unit than a few hundred times its value, and no inconvenience can be experienced in such cases; whilst the introduction of a new term, such as the "carcel," would lead to unnecessary confusion.

The expression of opinion that the source of light to be used as a standard must be produced by the process of combustion, and be in the nature of a flame, is well advised in view of the experience of the past. As I pointed out in my previous paper in 1888, numerous investigations had been made as to the possibility of producing a constant light by a process of incandescence of solid bodies, notably platinum; but the unreliability of such methods was well illustrated by the researches of the British Association Committee, aided by the work of this society, through its secretary, and since that time no progress seems to have been made in this direction. The suggestion to obtain a constant light by means of the incandescent electric lamp has completely broken down, in consequence of the more or less rapid depreciation of the initial intensity, owing to the gradual discoloration of the interior surface of the glass globe.

The following series of special experiments on this point will serve to show the difficulty with which such a standard would have to contend. The tests were made when the current was practically constant:—

No. of Hours the Lamp had been alight.	Illuminating Power.
0	14·8
96	14·0
188	13·0
307	11·5
357	11·8
453	10·8
520	11·5
612	10·5
709	10·5
761	10·5

The loss of 5·4 per cent. in the first 100 hours might not be considered an insuperable difficulty, as a lamp could be renewed at more frequent intervals. Another practical difficulty, however, is the variation in voltage of the current, a loss of only 3 per cent. having been found to affect the quantity of light by as much as 27 per cent. From these facts it will be seen that the committee had good reasons for their decision.

The conclusion that Mr. A. Vernon Harcourt's pentane air-gas flame constitutes a very exact standard is only one more piece of evidence in favour of the admirable work of that gentleman. Although the particular form in which the pentane and air are to be employed, if the decision of the committee takes legal effect, has been varied by the introduction of the pentane-Argand burner, the thanks of the community are due to Mr. Harcourt for first calling attention to the standard combustible material thus adopted. Without his preliminary investigations in this direction, it is probable that the question would have still been further from solution than it is at present. It is, indeed, only due to that gentleman to place on record once more the altogether admirable work with which his name is associated.

It is to be noted that the work of the committee resulted in the discovery of a point in connection with the one-candle pentane air-gas flame which had been overlooked in certain previous investigations. This was that when the flame was set by an observer who viewed the whole of the luminous portion, the tip of the flame was set too high as compared with the settings made when the body of the flame was obscured by a screen. A number of experiments made to determine the error thus introduced, gave a mean difference of 2·59 per cent. On applying this correction to those average results obtained by means of the pentane flame, when it was set without the use of a screen, the committee found the following values of the pentane air-gas flame, as obtained at various periods by different observers, who had compared this proposed standard with candles:—

Observer.	Value in Standard Candles.	Date.
Mr. Vernon Harcourt	0·994	1879
Messrs. F. Livesey & W. Brown.	0·990	1879
Mr. Harold B. Dixon	0·998	1881
Mr. Dibdin	0·998	1887
,, or, including all experiments	1·016	1887
British Association Committee	1·006	1888
Mr. Greville Williams { a	1·008	1891
Mr. Greville Williams { b	1·050	1891
Prof. Harold B. Dixon	0·998	1891-2

The mean value of all experiments made between 1878 and 1892, with the pentane unit against standard candles when thus corrected, ascribes a value of 1·007 to the pentane flame. If one abnormally high result be omitted, the value becomes 1·001.

Satisfactory as this result was, it was nevertheless felt that in order to reduce, as far as possible, any errors which atmospheric influences might introduce, it would be best to adopt for the daily testing of gas, a standard burner giving a light nearly approaching that of the flame to be tested, which can be easily worked, and in which slight errors in manipulation shall not give rise to serious errors in the results. The 10-candle pentane Argand seemed to satisfy these conditions, and the committee undertook the requisite experiments to determine the point. The burner used was supplied by Messrs. Sugg and Co., and on standardising it under the prescribed conditions by the one-candle pentane air-gas unit, it was found to give a value of 10·004 candles. The preliminary experiments to ascertain if very extreme variations in the height of the flame affected the amount of light given out, showed that with the extreme limits possible, which could never be approached with the most careless manipulation, the deviation from the normal value would only raise the standard by 1·0 per cent. or decrease it by 6·2 per cent., this latter result being obtained when the flame was tailing above the top of the chimney! An extended series of observations was made to ascertain within what limits of height of flame the light passing under the screen of the standard burner remained constant. At the same time the effect of replacing the air with coal gas was tried to see whether any, and if so, what difference would be caused thereby. The result showed that both with air and with coal gas the 10-candle pentane Argand gave practically uniform results with a flame burning between the limits of 2½ inches and 4½ inches in height, whilst if by any mischance these very wide extremes should be exceeded, the results obtained are slightly in favour of the gas being tested. In like manner, experiments made to ascertain whether the depth of pentane in the carburetter influenced the light by altering the amount of air space over the surface of the pentane resulted in showing that as long as there is sufficient pentane to cover properly the bottom of the carburetter, the results obtained will not vary, whilst they again established the fact that atmospheric air may be used instead of coal gas as the carrying medium. Another most important point is that the temperature of the carburetter may vary about 40° Fahr., viz., from 40° to 80° Fahr., without influencing the value of the standard. The only alteration found was in one case, when the level of the pentane was too low; but when the carburetter was kept about half full of pentane, the results were constant.

Testings were further made to ascertain what change, if any, the 10-candle pentane Argand might undergo as the atmospheric pressure varies; from these the conclusion was drawn that the value of the standard is not materially affected by such variations of atmospheric pressure as commonly occur.

The important point of uniformity was then tested. For this purpose Mr. Sugg was requested to make two dozen of the burners, which were distributed amongst members of the committee, who found that they all gave results practically identical with one another, showing that no difficulty will be experienced in producing a number of these burners suited to serve as standards.

In order] to ascertain whether the burner first submitted was capable of modification so as to simplify its construction, without affecting the constancy of the light emitted by the flame when at various heights, a number of experiments were made, with the result that the committee arrived at the conclusion that the 10-candle pentane Argand would, with a slight modification, be in every respect a trustworthy standard when supplied with atmospheric air carrying the vapour of pentane supplied by the carburetter provided. The modification alluded to consisted in the substitution of a rectilinear for a curvilinear solid cone, for greater convenience and certainty in measurement, and defining the distance at which it is to be fixed below the centre opening of the burner.

The following description of the 10-candle pentane Argand air-gas standard, as recommended by the committee for use in gas-testing, is given in Section IX. of the Appendix to the Report of the Committee.

Description of Dibdin's 10-*Candle Pentane Argand Air-Gas Standard, as recommended by the Committee for use in Gas Testing.*

The apparatus used in producing this standard of light consists of two separate portions, viz., the burner and the carburetter.

The burner is a specially constructed tri-current Argand burner, the annular steatite ring being perforated with 42 holes, each hole being 0·71 millimetre in diameter. The three air currents are:—(1) The central current rising inside the steatite to the inner portion of the flame; (2) a current rising outside the steatite, and caused to impinge upon the flame by an inner metal perforated and incurved cone, the top of which is level with the top of the steatite; (3) an outer current rising on the outside of the above cone, and between that cone and the glass chimney.

The inner perforated cone is punctured with 10 apertures 0·25 inch in diameter, which are provided for the purpose of equalising the two outer currents of air as may be required to suit the height of the flame.

The glass chimney is carried in the groove provided on the outer cone, which answers the purpose of a gallery, the dimensions of the chimney being 6 inches high and 1½ inches inside diameter. The top of the flame should be maintained as nearly as possible at three inches above the steatite, this point being indicated by the wires crossing the blue glass screens carried on each side of the burner on the metal supports. The flame is steadied by the small air-directing cone situated centrally beneath the steatite, the apex being 0·03 inch below the metal support carrying the steatite.

On the side of the burner to be presented to the photometer disc a metal screen, 8½ inches in height, is placed, and screwed securely to the base-plate. The middle portion of this screen is cut away, so as to leave above the top of the steatite burner an opening 2·15 inches in height and 1·4 inches in width, the lower portion of this opening being exactly level with the top of the steatite. The light emitted horizontally through this opening by the flame produced by the combustion of the gaseous mixture of atmospheric air and pentane formed in the carburetter described below is used as the standard of light. It is equal to the light emitted by 10 parliamentary sperm candles.

The lower portion of the screen has an opening 1 inch wide by 2·3 inches in height, to allow free access of air to the under portion of the burner.

The various dimensions and arrangements of the parts are more particularly described in the following table of measurements.

The position of the burner in relation to the photometer disc is to be fixed by the burner fitting gas-tight into a faced joint attached to the photometer at the required point; and the burner is to be set at such a height that the centre of the illuminated disc and the bottom edge of the cut-off shall be in the same horizontal plane. The length of the connection between the burner and the carburetter may be varied, but should not be more than 5 feet.

The centre of the flame is to be immediately over the terminal point of the photometer-bar.

The carburetter for the 10-candle pentane-Argand consists of a circular vessel constructed of tinned plate—

Diameter	203·2 mm. =	8 inches.
Depth	50·8 ,, =	2 ,,

having a spiral division 25·4 mm. = 1 inch in width. This division is made by soldering in a spiral strip of metal 4 feet 6 inches in length, and 2 inches wide gas-tight, to the under side of the top of the carburetter, so that when the top is fixed on, the bottom of the strip comes close to the bottom of the vessel and is sealed by the pentane, so that the air has to pass over pentane for a distance of about 4 feet 6 inches, and becomes thoroughly saturated.

At the end of the spiral division, near the side of the carburetter, a bird fountain is fixed for charging the carburetter, and keeping it charged at a constant level with liquid pentane.

The lower end of the inlet fountain tube is closed, and rests upon the bottom of the tank.

Through the side of the tube, which is $\frac{4}{10}$ths of an inch (10·1 mm.) in diameter, 16 holes 1 mm. in diameter are bored close to the bottom; and through these the pentane enters the carburetter. At one side of the inlet-tube, and 1 inch from the lower end, a small tube 33 mm. in diameter, and 20 mm. in length, is connected thereto, and turned upwards. The fountain inlet-tube is carried up through the top of the carburetter, and continued in the form of a bulb having a capacity of about 200 c.c. Stop-cocks are provided at the top and bottom of the bulb for convenience in filling with pentane, and the portion above the upper stop-cock is opened out in a funnel shape for the same purpose. When the carburetter is being charged, the gas must be extinguished to avoid the risk of the vapour firing and causing an explosion.

The inlet for gas or air is at the side of the carburetter, and at one terminal of the spiral division, the outlet being placed in the centre of the vessel, so that the air or gas may travel over the liquid pentane throughout the whole length of the spiral division, and thus become fully charged with the volatile vapour of the pentane.

When using this standard, the pentane must be visible in the fountain bulb.

Measurements of Mr. Dibdin's 10-*Candle Pentane Argand Burner.*

Number of holes	42			
Diameter of holes	0·71	mm.	= 0·028	in.
Inside diameter of steatite ..	9·90	,,	= 0·390	,,
Outside diameter of steatite.	19·05	,,	= 0·750	,,
Diameter of inside of metal cone at top	23·62	,,	= 0·930	,,
Chimney length	152·4	,,	= 6·000	,,
,, inside diameter ..	38·1	,,	= 1·500	,,
Height of cut-off..	54·61	,,	= 2·150	,,

The centre of the flame to be immediately over the terminal of the photometer bar.

This form of standard has been modified so as to yield a light of 1 or 2 candles, as desired; also 16 candles. In the case of the burner yielding 1 or 2 candles, as required, the flame may be used in two ways, either with or without the screen, or "cut-off." If without the screen it is equal to 1·0 candle when the flame is 1·25 inches in height; and to 2·0 candles when 2·30 inches in height. In either of these cases of course there is no "allowable variation" in the height of the flame. When the screen is employed, however, the value of 1 candle is obtained, when the screen is set 0·92 inch above the burner, and the height of the flame is kept within from 1·5 to 2·0 inches; thus having an allowable variation in height of half an inch. The value of 2·0 candles is obtained when the screen is set 1·64 inches above the burner, and the height of the flame is kept within from 3 inches to 4½ inches; thus having an allowable variation of 1½ inches. The chimney employed with this standard being 4·5 × 1·25 inches inside measure.

The term "allowable variation" is used merely to indicate the tolerance of the burner in unskilful hands, so that if by a mistake or error of judgment the height of the flame is not fixed to the mean point, but is anywhere within the limits of the allowable variation, the results will not, for all practical purposes, be vitiated. In exact work, however, it is always to be understood that the height of the flame should be that indicated in each case as the mean of the "allowable variation," viz., with the one-candle screened flame, 1·75 inches; and with the two-candle screened flame, 3·75 inches. In like manner, the allowable variation of the 10-candle pentane-Argand is from 2·5 inches to 5 inches, and that of the 16-candle pentane-Argand from 3·5 to 7 inches,

The pentane employed to produce the air-gas used in Mr. Harcourt's one-candle standard, and in the carburetter of the 10-candle pentane-Argand, was obtained by purifying light petroleum by the successive action of sulphuric acid and soda solution, and then distilling at 60° C., at 55° C.; and twice at 50° C. It was, however, considered important to obtain samples of pure isopentane from other sources in order to ascertain if the air-gas prepared from them would give the same amount of illumination as with the normal pentane. For this purpose a sample of so-called pure isopentane was obtained from Berlin, but on examination proved to be unsatisfactory. Accordingly, Professor T. E. Thorpe was requested to have a sample of pure isopentane prepared. This task he kindly undertook, and with the assistance of Mr. A. Greeves three specimens were made and submitted to the committee. The method used was, shortly, as follows:—The mixture of active and inactive amyl alcohols, obtained by the purification of fusel oil boiling ftom 120° to 132° C. under a pressure of 760 mm., was converted into a mixture of iodides, which was then reduced to isopentane by means of the zinc copper couple. Three samples were thus prepared from German, Scotch, and Irish fusel oils, all the conditions being strictly comparable. These were handed to the committee and experimented upon both with the one-candle pentane flame and the 10-candle pentane-Argand. In the case of the former it was found that rather more light was yielded by the isopentane than by the normal pentane obtained from petroleum. In the case of the 10-candle pentane-Argand, however, identical results were obtained with either sample; this doubtless being due to the remarkable compensating action of the flame yielded by that burner in a manner similar to the compensating action which takes place when air is replaced with coal-gas as the medium for driving forward the vapour of the liquid pentane in the carburetter. This result points to the conclusion that, the pentane-Argand enables either of these combustible materials to be employed without any practical difference in the amount of light passing under the screen, and employed as a standard, hence, should there be at any future time a suspicion that commercial pentane has altered in respect of its illuminating value, it can always be standardised by an appeal to the light of the pentane-Argand burner fed with air carburetted with pure isopentane.

An important question having been raised by Mr. John Methven as to the effect of the humidity of the atmosphere upon the amount of light emitted by a luminous flame, the committee gave the matter very careful consideration, and a prolonged series of experiments was undertaken by the secretary, Prof. Vivian B. Lewes, F.I.C., to elucidate the matter.

Mr. Methven had found that when the temperature was practically constant, candles gave per 120 grains of sperm consumed, a light equal to 1·104 as compared with a constant source of light (Methven screen), and that this was increased to 1·196 when the air in which the candles were burning was dried. This difference in the light value he considered to be due entirely to the removal of the moisture, as the temperature remained the same. He also found that when air saturated with moisture at increasing temperatures is supplied to a flame, the light value rapidly diminished, so that between the temperatures of 50° Fahr. and 75° Fahr. a diminution of 10 per cent. takes place in the light emitted by an Argand flame burning 5 cubic feet of gas per hour, while with a flat flame a reduction of 12·2 per cent. took place, and with a gas flame from a two-candle burner a loss of 13 per cent. was found within the same range of temperature.

Mr. Methven ascribed these differences to the different power of the flames to battle with the aqueous vapour. The result of the committee's experiments was that, although by abnormally saturating or drying the air supplied to a flame, variations as great as those obtained by Mr. Methven undoubtedly occur, yet that, in a well-ventilated testing-room, with the temperature kept within a narrow range, no such great differences are to be found. These conclusions were also supported by the experience of Mr. Vernon Harcourt, Mr. Greville Williams, and Mr. W. C. Young; and it did not, therefore, appear to be necessary to take this otherwise important point into consideration in connection with the inquiry, especially as the value of the standard recommended was so close to that of the light to be tested, and thus any variation in the one would be balanced by that in the other.

In view of the definite results obtained, the recommendation of the committee to the effect that the gas referees should be authorised, should they at any time see fit, to approve and certify for gas-testing any other flame based upon the 10-candle pentane Argand would appear to be unnecessary, as opening the door to alterations from time to time, and thus again reopening the question which all desire so earnestly to see settled. The provision, however, that no alteration should be so made without the sanction of the Board of Trade and the gas companies, would provide a safeguard against any interference with the standard on trivial grounds, is well advised. But undoubtedly the other parties to the contract, viz., the controlling authorities, as representatives of the public, should be equally represented with the gas companies, and doubtless this will be provided for in any Act legalising the present proposed alteration. In that case, no objection can be raised to the clause, and the advantage gained would be that in case the advance of knowledge should place at the hands of the operator a still more convenient and reliable process, it would not be necessary to incur the delay and expense of another Act of Parliament, the needful authority for the change being merely a notification of the gas referees to that effect.

In this connection I have much pleasure in calling attention to a form of 10-candle pentane burner proposed by Mr. A. Vernon Harcourt, in which the pentane is burnt after the manner of petroleum, in that the vapour is raised to the metal burner by the agency of a cotton wick, the air supply being admitted to the burner from outside as in the case of the P_2 one-candle lamp of that gentleman. With reference to this suggestion, I am unable to speak in the absence of experience with it in practice; but whether in regard to this or any other method which may be proposed hereafter, I have only one wish, and that is, that the public should have the benefit of the best available means of producing a standard light, and that whenever a better system than the pentane-Argand is found, I shall be one of the first to advocate its use. Sixteen years ago I advocated the adoption of the Keate's lamp; seven years later I found that the Harcourt one-candle standard gave better results in the hands of various operators than the apparently more delicate Keate's system; and I used my best endeavours to obtain its adoption. Now that it is universally admitted that the pentane-Argand which I have since elaborated so as to provide a good working instrument as well as an accurate standard, is by far the most desirable form, if not the only practical one acceptable to all parties, I desire that its use shall be legalised; and that, in order that there shall be no "dog-in-the-manger" policy, the machinery should be provided by means of which any improvement of the present best known method may be legalised without the cumbrous "Act of Parliament" having to be called into requisition.

To many it may seem to be a matter of regret that the question of the method of burning the gas to be tested should have been imported into the question, as tending to complicate the simple question of the standard of light, especially as it is a question of how far any benefit would arise to the public generally by such a change—the possibility, indeed, being that it would tend solely in favour of the sellers of gas rather than the users. As, however, the gas companies were urgent in representing the desirability of this point, as appears from the notes of the interview which the committee had with the representatives of the Incorporated Institution of Gas Engineers and the Incorporated Gas Institute, such an alteration as proposed, viz.:—"That the requirement that the gas shall actually be consumed at the rate of 5 cubic feet of gas be rescinded, so as to allow the gas referees to sanction a mode of testing in which the gas shall be burned at whatever rate is found requisite, in order that it may give a light equal to that of the prescribed number of candles;" or, in the words of the gas representatives, "That the rate of the consumption of gas to be tested be adjusted as nearly as practicable to the maximum efficiency of the various standard burners," does in effect upset the existing bargain between the gas companies and the public, as repeatedly sanctioned by Parliament. The simple substitution of a reliable for an unreliable standard is a question which does not affect the existing contract, whereas the committee afford no evidence of an experimental character to warrant the further change thus proposed.

Having thus fully considered the most recent work in this connection in England, it will not be without interest to discuss the most modern work on the Continent on the subject. This is contained in the Report of the Dutch Gas Association on Photometry which was issued in 1894. The report is an able and exhaustive account of a special inquiry upon the whole question of photometry as applied to the estimation of the illuminating power of coal gas, and especially so with regard to the standard of light. After a careful *resumé* of the work hitherto accomplished in this direction, the committee of the association arrived at the conclusion that none of the existing proposals met all the requirements of an ideal standard, and, consequently, proceeded to devise a method which they considered fully answered all purposes. It is to be noted that their report contains no reference to the pentane Argand which does not appear to have attracted their attention, although it has now been before the public for nearly ten years, but in a less prominent form than it has now assumed in consequence of the work of the Board of Trade Committee.

The lamp designed by the Dutch Association is based upon the one-candle pentane lamp, known as the P_2 lamp, of Mr. Vernon Harcourt, in which that gentleman employed the device, first introduced by myself, of cutting off the top portion of the flame, by means of a screen, in a manner similar to that employed in the pentane Argand. Instead of using pentane for the fuel, a mixture of 9 of benzol to 100 of sulphuric ether is preferred. Experiments showed that between 7·7 and 11·2 parts of benzol the effective variation of the light is only 1 per cent.; whilst between 8·5 and 10·2 parts it is only 0·1 per cent., and the light is therefore practically constant when the benzol varies between 8·5 and 10·2 parts to 100 of ether. This mixture, made up with ether of specific gravity of 0·7215, and benzol of specific gravity of 0·886, had a specific gravity of 0·7335, all at 15° C.; but it was found that, after 33 per cent. of the contents of the reservoir had been burned away, the residue retained exactly the original specific gravity of 0·7335. The mixture had, therefore, evaporated, as a whole, and could thus be used as a standard fuel for the lamp. Various experiments with pure and impure ether showed that no difficulty could be experienced in daily work from casual impurities, although pure ether is recommended for use in standard instruments. Using this arrangement as a standard the Dutch Committee found that the Amyl-acetate lamp = 0·9213 candle, = 0·8333 German candle; the English candle = 1·0854 Amyl-acetate lamp, = 0·9045 German candle; German candle = 1·2 Amyl-acetate lamp, = 1·1053 English candle. Three specimens of the Carcel lamp were tested with the average result that the Carcel is equal to 9·631 English candles, which agrees with the Kirkham and Sugg's experiments in 1869, who found the Carcel to equal 9·6 candles; and the tests made by myself, in 1885, when comparing it with the Keats' lamp, the result being 9·61. A series of tests against the one-candle pentane air-gas flame made at the same time as those with Keats' lamp gave a mean result of 9·35, which, however, corrected for the method of setting the pentane then employed, as above described, by the factor 2·59 per cent., a correction only discovered seven years later, gives a result equal to 9·63. These remarkable coincidencies of the results of different observers at widely different periods, and by equally widely different methods, are not a little satisfactory in many respects, and serve to show the nature of the work which can be accomplished when a sufficiently large number of experiments are made to eleminate the accidental errors due to isolated tests.

From the above *resumé* of the position of the question of providing a substitute, acceptable to all parties, for the present legal candle, it will be seen that all that remains to be done is for Parliament to sanction the proposed change; and by thus legalising the pentane-Argand, bring to a conclusion a question which has gradually ripened until it would seem as if the last word had been said; and there is nothing to delay the closing scene by Parliamentary action. Sufficient time has elapsed since the publication of the report of the committee for thorough trial of the new standard; and there should be now no question as to the result. It is to be hoped that the discussion of the facts which I have ventured to place before the Society will be such as to strengthen the hands of the Board of Trade when dealing with the matter during the ensuing session of Parliament.

DISCUSSION.

Mr. A. **Vernon Harcourt** F.R.S., said he could add but very little to what Mr. Dibdin had said; for if he had been asked to give a paper on this subject, having in his recollection the work of the committee on which both Mr. Dibdin and himself had been engaged for two years, it would have borne a great likeness to the one they had heard; and there were only one or two points on which he should wish to make any addition. Perhaps it would have been wiser if the committee had limited itself to the matters referred to it, and only made a recommendation as to the standard of light; but it did make a recommendation as to a nearly related subject, which affected the actual use of the standard in testing the illuminating power of gas. The recommendation was that, instead of the gas being tested at the uniform rate of 5 cubic feet per hour at the standard burner which had been prescribed for testing purposes, it should be burned at such a rate as would give from that burner a uniform light of 16 candles. Working in that way the test might still be regarded as giving the illuminating power of the gas by assuming that the quantity of gas required to give a certain amount of light varied inversely with the quality of the gas. That was substantially true; and if the recommendation were adopted there would be the advantage that the quality of the gas would be judged precisely from the consumers' point of view; for that which mattered to the consumers was the quantity of gas which would be burned to produce the desired light. It was very important that the knowledge should be as widely spread as possible, that the eye was a very bad photometer, and that one could not tell by looking at the light of a burner what the quality of the gas was. Complaints of bad gas arose nearly always in consequence of the gas reaching the burner at insufficient pressure; the light was therefore small, and the consumer complained that the gas was bad. Actually it was not possible over a very wide range of quality, to judge, from looking at the flame, as to the quality of the gas being burned; the actual difference was in the quantity, and that eluded observation. There were so many other circumstances which might affect the quantity which passed through the meter—the number of burners that were lit, the time during which they were burning, the fixing of additional or different burners, the use of gas for cooking and heating—which sufficiently accounted for the variation in the meter-record; but amongst the various causes which might increase the consumption was one which could not easily be separated from the rest, namely, that due to the variation in quality. It was for this reason that the Committee, though perhaps going a little out of their way, recommended that the measure should be of the quantity of gas which was burned in order to give a fixed amount of light. Such a mode of testing would correspond, more nearly than the present, with the effect on the consumer of a variation in the quality of gas, and it would do more justice to those who supplied it. With the particular burner used a really small variation in the quality was indicated by the present method as greater than it really was. If the quality of the gas were rather less good than usual, when only five cubic feet were burned the amount of light underwent a considerable diminution; but if the experiment were made of trying how much the volume of gas needed to be increased in order that 16 candles should be obtained, the actual deficiency would not come out nearly so large as it appeared on the present system. He might add that, as one of the Committee, he tried over again some of the experiments Mr. Dibdin had made with his burner on the effect of variations of conditions, such as might happen in actual practice. He had made some of the experiments described in the paper. Placing the carburetter in warm water and packing ice upon it, and comparing the light the burner gave, he found it to be constant: the quantity of pentane vapour evaporated, even at the low temperature, was so considerable, and he steadiness of the light given was so great, that with these variations in temperature there was no measurable effect on the amount of light given. He had also carefully tried the effect of varying the height of the flame, and it was certainly the case that, whether it stood at such a height that the top just reached the lower edge of the screen, or whether it was nearly flaring above the chimney, the amount of light given out in the photometer was practically constant. He could only re-echo the wish that the labours of the committee might not prove to have been ineffectual, but that they might at last see accomplished what had been so long wanted, the establishment of a standard of light which should give constant results, and be more satisfactory than the extremely uncertain candle both to the consumers and the gas companies.

Mr. J. **Methven** said he had been watching the behaviour of this pentane standard of Mr. Dibdin during the last few months, and had compared it against candles. He had had half-a-dozen operators at work, who had made 500 separate experiments, and it was found, as the result of the average, that the power of the burner was equal to 10·283 candles.

Of course, it ought to be equal to 10, and he was glad to have the opportunity of stating the result of these experiments, because, naturally, an increase of nearly 3 per cent. on the 10 candle was almost equal to half a candle on 16-candle gas, and inasmuch as the extra enrichment of half a candle would cost the gas companies of London about a halfpenny, it was obvious how they would be affected by that additional value being put on the standard. Mr. Dibden referred to experiments made many years ago to determine the value of the pentane standard of Mr. Vernon Harcourt, and he remembered them well, and had the pleasure of working with Mr. Harold Dixon on that subject. He remembered also the room in which they were made and the photometer which was used. He had no doubt that the character of the photometer materially affected the results, that was pretty well established. The room was not built for a photometer room, and though large in area was low-pitched and poorly ventilated. Supposing at that time the pentane standard was equal to the candle, and admitting that Mr. Dibdin's ten-candle burner was ten times the power of that how was it he now found by his 500 experiments that the Dibdin burner was equal to 10·283? There must be something to account for this. Of course it might be due to the candles, but he took the precaution to use 500 separate candles, not 250 cut in half; six operators were engaged, and the difference between the six was very small indeed. The highest result was 10·3 and the lowest 10·1. It seemed rather hard on gas companies to have to submit to the introduction of a standard which was nearly 3 per cent. higher than the result of experiments on 500 candles. Mr. Dibdin seemed rather to regret that the Committee had introduced any alterations in the mode of consuming the gas to be tested, but he thought they had not gone far enough, because one very important matter in settling the question of these standards was to determine the photometer in which they were to be used. In the various official testing stations were various forms of photometers; the Evans box photometer which had been converted and altered at the suggestion of the referees of London; and also the open Letheby photometers, and he believed there was a considerable difference in the results shown by the Dibdin lamp in these two photometers. His experiments were made with the open Letheby photometer, modernised with a 60 inch bar. With regard to the effect of the humidity of the air on these flames, his experiments, made some years ago, conclusively proved that varying degrees of humidity of the air used for consuming pentane had an effect on the light obtained from candles or a gas burner. He thought the subject had been exhausted, and was surprised a fortnight ago to find in the *Journal of Gas Lighting*, a report of some experiments by Dr. Emil Liebenthal on the effect of the humidity of the air on the Hefner and pentane lamps; these seem to have been very exhaustive, and entirely corroborated his own results; which seemed to show that some correction for humidity should be made. It appeared that during the different months of the year the amount of light varied to the extent of 3½ per cent., and in one or two months the variations were as great as 5 per cent., owing to the different proportions of aqueous vapour in the atmosphere. Without casting any reflection on the manner in which the committee made their experiments, he thought the importance of the subject required that further investigation should be made before a new standard was introduced. They wanted a standard which was beyond suspicion. Candles were not reliable, and gas-makers would hail the introduction of a standard which would remove the vagaries with which they had been troubled so long.

Mr. J. Cadett said he had used the pentane-Argand, both the two and ten candle, during the last two years as a standard for photographic purposes. In such cases they did not expect to work to three places of decimals of a candle, but as far as they could observe, using ordinary care, they were quite unable to notice any difference in testing with the pentane-Argand. Of course there were possible errors introduced by variations in the plates, quite apart from personal errors of the photographer, and as a photographic standard, he was perfectly satisfied with it. In quality, it varied a little from daylight, but he presumed that a factor could be formed for that difference which would be sufficiently accurate for practical purposes when plates of the same class were compared. With orthochromatic plates, however, there was a very great difference, involving considerably more than 100 per cent., but that, again, simply meant the establishment of another factor.

Mr. Lloyd asked if Mr. Methven could give the largest difference in the results found by the individual operators who made his experiments. These differences might be large, and yet the average of the differences between them might not be great.

Mr. Methven regretted he had not the figures which would enable him to answer the question, but the average difference and the mean of the whole was what he had stated, and the candles were all certified by the referees.

Mr. Lloyd said he was for many years a gas examiner, but was one no longer, and spoke simply as a member of the public. Every one in London was interested in having a reliable standard for the gas they used and paid for, and the present system was an absolute farce, the differences were so great between the standards used. Even Mr. Methven said the present standard was not reliable, but the gas manufacturers were not content to take a standard which was more reliable than the one now in vogue, but were asking for one which was absolutely perfect. If they waited for that they would make no progress whatever. The Government ought to look after the interest of the public, and that was best done, not by interfering with scientific questions, on which scientific men ought to be the sole authority. If the Government would select gentlemen to fill the position of gas referees, who would put as much knowledge and ability into the work as Mr. Vernon Harcourt, and have a fair number of them, all scientific questions might be left to them, and they would not be bound down by Act of Parliament to something which was proved to be unscientific. With regard to the statement that the result might be affected by photometry, it simply amounted to this, that any scientific operation, if not conducted under proper conditions, did not give accurate results. But those conditions should be laid down by scientific men, not by the Government or members of Parliament who did not pretend to be scientific experts.

Col. **Allan Cunningham**, R.E., thought they had had brought before them a standard of light which he hoped might prove to be of much wider use than the purpose for which it appeared to have been invented, the testing of pure gas. It might be used to test the illuminating quality of other materials, such as petroleum, or for photographic exposures, or for other scientific purposes. He presumed the material burned could be obtained beyond suspicion, but not much had been said about the medium in which it was burned, which might affect the light very much. As regards the air, the chief differences would be pressure, heat, and hygrometric quality. A considerable range of temperature seemed to have been tried, but, as regards pressure, he gathered that the only variations referred to were those found in London; now, both in this respect, and also with regard to humidity, much greater differences were found in other parts of the world, where, perhaps, this standard might be useful. In India there were stations at an elevation of 7,000 feet, and the standard might have to be used in a mine 3,000 feet deep. In hot countries there was sometimes hardly any moisture in the air at all, and at other times it was perfectly saturated. To go back to the pressure, that must affect the amount of oxygen supplied to the flame, and there were other ways in which the light might be affected by the state of the atmosphere, such as the amount of dust or fog present. If the standard of light and the thing to be tested were both compared at the same time, the conditions being the same for both would not be material, but if it were compared with an incandescent material, enclosed in a glass vessel, the state of the air might affect the result a great deal. Fog and dust would also have varying effects according to the distance through which the light had to pass.

Mr. **Campbell** said a point which had not been touched upon was the presence of carbonic acid in the air. In July or August last a series of researches were made in Germany on the amylacetate standard, and also on Mr. Harcourt's pentane standard, under varying pressures and different conditions, as to the amount of moisture and of CO_2, and it was found that the influence of the latter element was very great. He believed the addition of one part in 1,000 made a difference of 7 per cent. in the amylacetate standard; he did not know whether the experiment had been made with the pentane standard, but it seemed very important to consider it, especially seeing that these standards might be used in badly ventilated rooms. As far as he remembered, the experiments showed the atmospheric pressure was not of importance.

Mr. **Grafton** referred to some former experiments of Mr. Dibdin, which seemed to show that his light was equal to 16·7 candles by Mr. Harcourt's one-candle standard and Mr. Methven's two-candle standard, whilst those two agreed in returning the the gas as 16·3, instead of 16·7. Mr. Dibdin put down the four-tenths difference to variations in the candles, but he took it that was included in the average, and that ·4 was a figure which ought to be recognised, since, with 16-candle gas, it made Mr. Harcourt's standard 2·4 too high, and this would be exaggerated 10 times when they came to Mr. Dibdin's lamp. He had conducted a large number of tests — about 3,000 — and he could not get it to average 10 candles; he therefore thought there must be something radically wrong somewhere. He had also to complain that the chimnies for Mr. Dibdin's lamps were not cut off at right angles to their length, and therefore canted over when set up. He had no other fault to find with Mr. Dibdin's lamp except that it was too powerful.

Mr. **Lacey** said he had used this standard ever since it was first mooted, in his ordinary daily work, and found it very convenient and accurate. The paper was really on a standard which was constant, and he did not think they need discuss whether it represented any exact number of candles. The amount of light was definite, which that from a candle was not. No one could say what an average candle was, and you could only get at an average by testing some thousands. By this standard they would be able to actually test candles. The value of a standard, which was invariable, was apparent to everyone, but he thought it would be a great pity to make a 16-candle standard lamp; the 10-candle was very handy, and you could take the readings direct from the bar without calculation, but you could not with a 16-candle standard unless you had a special photometer bar. He considered the Committee was thoroughly competent and hoped the question would not be re-opened.

Mr. C. E. **Hearson** asked if pentane could be readily obtained, and whether there would be any difficulty with regard to its carriage, on account of its inflammatory nature.

Mr. DIBDIN, in reply, said he had found no difficulty in procuring pentane, and it generally came by carrier, it was no more dangerous than ordinary benzoline or ether, and many other things which were systematically conveyed about the country. Taking the points raised in order, Mr. Methven said an average of 500 experiments gave a value of 10·283 candles for this standard. Against that he had to place his own experiments, which numbered about 2,000, and those made by the members of the committee and others must have amounted to about 10,000; so that there were about 12,000 against 500. He could not cavil at Mr. Methven's results, but an average derived from 10,000 or 12,000 experiments must outweigh an average of 500. The question of photometers could now be settled without going to Parliament, because the referees had full powers, and he believed it was understood that when the standard was settled, the referees would, once for all, prescribe the photometer. His own experience was, that if a photometer were well ventilated, it did not matter whether you had a bit of wood at the back or a velvet curtain, or something in front or at the ends, so long as you screened the eye of the observer from lights, and avoided reflection from extraneous surfaces on the screen. The cabinet work did not matter. He preferred to burn lights in the open, but it did not much matter; but to surround your lights with upholstery did not seem to him the best way of doing it. When you had candles burning in a heated box, with insufficient ventilation, you could make them do whatever you liked. That was exactly what has been done in some of the experiments referred to by Mr. Methven. In some of his results he got an average of 16·3 as the value of a certain flame with the Methven 2-candle screen and the Harcourt 1-candle pentane flame, as against 17·0 as an average of all the results with candles. But that average of 17·0 was raised by including certain results which were obtained in a room purposely heated to a temperature of over 90°, and the candles behaved in such a way owing to the rapid volatilisation of the sperm that they began to smoke, and gave less light. Thus the value of the gas consumed was made to appear higher, and in many cases the 16·3 average flame, when tested by the candle, appeared to be up to 18 or 19 candles. In taking the average, he excluded all those results which came over 17·5. Thus the Harcourt lamp and the Methven screen agreed, and the candles, including tests which were obviously incorrect, gave results 0·4 too high. He was obliged to Mr. Cadet and Mr. Lacey for their support. Colonel Cunningham seemed to have an idea of carrying a standard of light all over the world, which was a grand idea, but the Committee of the Board of Trade recommended the adoption of this standard simply as a working standard for testing London gas, not as an absolute unit of light to be used everywhere. His own opinion was that it was the best standard for anywhere under present known conditions. What would be the variation at an elevation of 7,000 feet, or down in a mine, he had not had an opportunity of trying, but Mr. Vernon Harcourt had made some experiments with the one candle unit on the top of Ben Nevis against the light of an incandescent electric lamp, and he believed that the variation was very little, if any. If that were the case, probably the same result would be found with the 10-candle standard as the same argument applied. The effects of dust and fog were eliminated to a great extent by the fact that the distance between the standard and the light to be tested was usually very small, so that the fog would have to be very considerable before any readable difference would be introduced. Mr Grafton also raised the point that his chimnies were not always nicely ground at right angles, but if anyone choose to purchase something which was not what it ought to be, they must take the responsibility. He was glad to hear Mr. Lacey recognise the fact that the Committee had done their best to arrive at a practical solution of the question. He thought the tone of the meeting was such as to justify the decision at which the Committee had arrived.

The CHAIRMAN, in proposing a vote of thanks to Mr. Dibdin, said anybody who had ever had to work at photometry with candles would agree that the sooner this standard was got rid of the better. They must recollect, however, that they had to educate Members of Parliament, who were usually ignorant of scientific and technical matters. If they could get them to vote for the introduction of a proper standard, no one would be more rejoiced than himself. He could not say that he looked upon the standard proposed as a perefect scientific standard; he thought eventually the unit of light would have to be an incandescent solid of some kind, but for purposes such as gas testing it was the most convenient and practical one yet proposed. Every one who had watched this question, as he had done, for a great many years, would acknowledge with what care Mr. Vernon Harcourt had worked out the details of the pentane standard. In the original form it was a naked flame, and he must confess that he liked naked flame better than one enclosed in a chimney, because there was an amount of uncertainty about the absorption of glass which you could not be sure of finding out correctly. It might absorb or it might not, and it depended on the maker of the glass what kind of chimney you had. That might make a slight variation, which would materially interfere with the results for scientific purposes. For photographic purposes, a chimney of a certain kind of glass—apparently colourless—would give a very different result to that obtained with a chimney made of another kind of glass. Again, when the flame was very high or low, even within the limits indicated by Mr. Dibdin, there was a slight variation of photographic intensity, which would have to be taken into account when making exact measurements; but, as regarded the optical properties, he had found no variation when it was raised or lowered. Probably, the explanation which had been given was correct, and the difference in photographic intensity might be accounted for by the different proportion of blue rays, which were so photographically active. No doubt Mr. Cadett used due care in getting the flame right, and therefore did not get much variation. Colonel Cunningham's remarks were worth attention. He (the chairman) would have been glad of a standard of light at an altitude of 10,000 feet, where the air pressure was only equal to 20 inches of mercury; but he did not know what would happen with the pentane standard under such circumstances—very probably it could be so regulated as to be satisfactory. The paper to which Mr. Methven referred seemed an excellent one, and was well worth reading. One photometer ought to be as good as another if it were properly used, though the factor of delicacy of reading would vary according to the kind employed. It all depended on that. If you used a grease spot there were, a good many pitfalls open, and so many precautions had to be taken to prevent error that he preferred Mr. Vernon Harcourt's method of screens, but there was not time to enter into that question or some others he might have referred to. He hoped the discussion might help to educate members of Parliament, so that they might soon have a satisfactory standard for testing London gas.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

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ART EXHIBITION IN BERLIN.

At the same time that the city of Berlin is to have an exhibition of industrial objects produced by her factories and artisans, the artists of Germany are to have an exhibition of paintings and sculpture to commemorate the two-hundredth anniversary of the Royal Academy of Arts in Berlin. The exhibition is to be international, and the *locale* is that recently occupied by the International Exhibition of 1895. It has extensive grounds, which include various restaurants and bandstands. The committee includes the painter, Count Harrach, as president, and the painter, von Eckenbrecher, as honorary secretary. Other members elected by the Senate, and by the members of the Royal Academy of Arts, as well as by the Society of Berlin Artists, and by the Dusseldorf Academy, include the painters Knaus, Amberg, Thumann, and Carl Becker, the sculptors Siemering and Schaper. The business management is in the hands of Mr. Hermann Preckle, who may be addressed "Internationale Kunst-Ausstellung, 1896, Berlin. Landes Austellungs Gebäude." The United States Consul-General at Berlin says that exhibits are to be confined to paintings, sculpture, and architecture, and works of the reproductive arts, which have been produced during the last ten years, and not before shown in Berlin. Foreign works must be by living artists; there will be, however, a department for works by deceased and living members of the Royal Academy, extending from 1696 to 1896, and under special circumstances the committee may see fit to allow the exhibition of works by a deceased artist not a member of the academy. No artist can send more than three exhibits, and he must sign them. Copies are not admitted. Lists of intended exhibits must be in the managers' hands by February 15th, 1896, and foreign works must be delivered at the galleries between the 18th and 25th March. Prizes will be awarded by the German Emperor, advised by an international jury of winners of medals and orders, which jury shall not have works of their own in the exhibition.

WOOD CARVING IN SWITZERLAND.

The wood carving industry in Switzerland is, according to the *Handels Museum*, in a somewhat failing condition. Owing to the exertions of the exporting houses, the exports last year of carvings showed no perceptible diminution; but a decline in the home consumption and the sale to customers is noticeable each year. Large articles are not so often bought as formerly, and the whole trade is becoming more and more restricted to two or three months in the summer; whilst at other times there is lack of employment, except, perhaps, in the manufacture of a few staple articles. Germany and Austria still take the largest share of the exports. Owing to the high rates of customs' duty, France only receives a small quantity of Swiss carvings, and, in spite of the exhibition at Chicago, and the reduction of import duties from 35 to 25 per cent., the United States bought no more than in former years. Considerable attention has lately been devoted to the introduction of the manufacture of carved furniture, and the carving school at Brienz is already preparing workmen for this branch of industry; but before the new industry can be successful, it will be necessary for properly fitted up cabinet makers' workshops to be established, where capable furniture makers could be trained. The work of the Brienz Carving School is very successful and extensive. The school gives instruction to an annually increasing number of pupils, extensively recruited from the wood carving districts, both in the theory and practice of the art, and endeavours to educate their sense of beauty and form. The productions of the students, as well as those of the members of the Brienz Industrial Union, who are mostly carvers and manufacturers in a small way, are exhibited and offered for sale in an industrial market. Endeavours are now being made to extend the market for these goods, and, amongst other things, the establishment of exhibitions of samples and sale-rooms in America is being considered. The question has also been raised whether the water power of the Aar could be utilised for the carving industry, but investigations carried out on this point have not yet been concluded.

MUSICAL INSTRUMENTS IN BULGARIA.

In the last report of the United Consul at Annaberg to his Government, some interesting particulars are given respecting musical instruments in Bulgaria. For about fifteen years the Bulgarian people have been in a state of transition, but now the views and habits of Western Europe are beginning to spread, and, consequently, the importance of Bulgaria for the export trade in general, and for the trade in musical instruments in particular, is increasing. The Bulgarians love music. They sing a great deal, not only at entertainments, but also at their work, in the house, and in the fields, especially during harvest. The shepherds or the reapers on the opposite heights often sing in alternation, stanza by stanza. The forest, in the dusk of the evening especially, inspires the people to sing. On journeys through the country, it may often be noticed at sunset how travellers, their servants, and the armed escort raise their voices in chorus, as if instinctively. The Bulgarian troops constantly sing on the march, like the Russians, with whom singing almost takes the place of drums and trumpets. In the towns, also, the educated classes seldom come together without singing. Every banquet concludes with singing and dancing, and the united singing of lyrical melodies, songs, and choruses largely takes the place of conversation. The tunes of the songs are certainly affected by the primitive musical instruments, partly, too, by the nasal chant of the Greek Church, and are monotonous. Under the influence of the new political, economic, and social life, the old primitive songs are beginning to disappear rapidly, and this change is of advantage, in so far as it is connected with an increased demand for modern musical instruments. The national instrument — the *gajda* or bagpipe—predominates throughout Bulgaria. The melancholy and monotonous tones of the bagpipe sound to the Bulgarian far from his home like a voice from the fatherland; and at harvest time singing is heard everywhere, accompanied by the bagpipe. The second national instrument is the *kaval*, an extremely simple wooden shepherd's pipe, producing a shrill note. The *gadulka*, or *cigulka*, is an instrument with two strings, from which melancholy tones are emitted. The gipsy fiddle, called *kemené*, is a superior instrument. The *bulgarina* (Turkish, *tambura*), the soft, monotonous jingle of which is often heard in private houses and taverns, is a sweet guitar with four strings, which is played upon by means of a goose quill, without vocal accompaniment. The Mohammedan Bulgarians of the Rhodope accompany their songs with a similar guitar, played with two fingers. This is called *drukja* or *bajalma*. All the instruments are manufactured by the *gajdari*, who formerly constituted in the town a special guild. It is only of late years that musical instruments have been imported in considerable quantities from abroad.

Obituary.

◆

Lord Leighton, P.R.A.—By the death, on Saturday afternoon, 25th inst., of Lord Leighton, President of the Royal Academy, the Society of Arts loses one of its most distinguished Vice-Presidents, a loss which will long be felt and deplored. Sir Frederic Leighton was elected a member of the Society in 1880, and he acted as vice-president from 1880 to 1883, from 1885 to 1889, and from 1892 to 1896. He was always ready to assist the Council in all those subjects with which he was specially acquainted, and one of the latest occasions on which he gave the Council the benefit of his unrivalled knowledge and taste was in 1895, when he acted as one of the judges of the specimens sent in for the prize offered by the Society for the Swiney silver cup. As Chairman of the Fine Arts Committee of the Royal Commission for the British Section of the Chicago Exhibition he took an active part in the selection of the admirable exhibition of British art which was so greatly admired at Chicago. It will be remembered that Sir Frederic Leighton was the moving spirit in the selection of British art at the Paris Exhibition of 1889, which did so much to awaken foreign interest in the just claims of the English school. He initiated the movement for a worthy representation of British art, and acted as Chairman of the Fine Arts Department of the British Section. The particulars of Lord Leighton's life are so well known, and have been so largely commented upon in the public Press, that it is not necessary to do more here than set down the two or three principal dates in his life. He was born at Scarborough on December 3rd, 1830, and first made his mark in 1855, when his grand picture of the "Procession of Cimabue's Picture of the Madonna through the Streets of Florence" was exhibited at the Royal Academy. He was elected an associate of the Royal Academy in 1864, and an academician in 1869. He was chosen President in 1878, and he, therefore, held that office for more than seventeen years. He was knighted in 1878, created a baronet in 1886, and just before his death he was created a peer, as Baron Leighton, of Stretton.

SIR JOSEPH BARNBY.—Sir Joseph Barnby, whose sudden death took place at his residence in St. George's-square, on Tuesday, 28th inst., was Musical Examiner to the Society of Arts in 1893 and 1894. He succeeded Sir John Stainer in the former year, but although he continued the examinations in 1894 he found it impossible to go on with them further on account of the engrossing character of his other duties, and he therefore resigned the office after that year. Sir Joseph was born at York on August 12th, 1838, and before studying at the Royal Academy of Music was a chorister in York Minster, from 1848 to 1852. In 1863 he was appointed organist at St. Andrew's, Well-street, moving in 1871 to St. Anne's, Soho, where he instituted the annual performance of Bach's Passion Music according to St. John. In 1872 he succeeded M. Gounod as conductor of the Albert-hall concerts—now the Royal Choral Society. In 1875 he was appointed Director of Musical Studies at Eton, a post which he held until 1892, when he was elected Principal of the Guildhall School of Music. In this same year (1892) he was knighted. He was well known as a composer, and his oratorio, "Rebekah" was produced in 1870. His loss will be widely regretted, and his name will long be remembered as that of one of the most successful popularisers of music in our days.

General Notes.

SOUTH KENSINGTON MUSEUM.—The late Mr. Carlo Giuliano, of 115, Piccadilly, has bequeathed to the South Kensington Museum a valuable collection of jewellery, consisting, for the most part, of gold ornaaments, decorated with minute granulations, after the Greek and Etruscan fashion. One of the necklaces has 52 amphora-shaped pendants, and is most delicately enriched with no less than 157,580 tiny gold granules. There are also some examples of enamelled jewellery, notably two flower necklaces, further ornamented with pearls and brilliants. Messrs. C. and A. Giuliano, the sons of the late Mr. Carlo Giuliano, have added to their father's bequest, not only a beautiful crystal case, but also a small reproduction in bronze of the beautiful statuette of Victory, found at Pompeii, and now in the Museo Nazionale at Naples. These admirable specimens of the goldsmith's and jeweller's art are provisionally exhibited in a separate case in the South Court of the South Kensington Museum.

TELEPHONES IN RUSSIA.—The number of State telephone systems in Russia in 1894 was 34, the number of subscribers 3,938, the length of line 2,582 verstes (1,712 miles), the length of wires 10,125 verstes (6,713 miles), and the number of apparatus 4,397. The *Handels-Museum* says that, as compared with 1893, the number of subscribers shows an increase of 32½ per cent , the length of line about 40 per cent., and the length of wire about 38 per cent. In 1894, 145,897 messages were exchanged on the State telephone lines. The number of telephone systems worked by private undertakings was the same in 1894 as in 1893, as the Government no longer grants to private undertakings concessions for the establishment of urban telephone systems. The subscribers to private telephones numbered 8,004 in 1894, and the length of line was 1,152 verstes (764 miles). In 1894, permission was granted for the establishment of 160 private telephone connections. The telephone is also used considerably by the railways. During the year under review, there were altogether in general use 45 telephone systems; the number of subscribers was 11,825; and the length of line was 3,735 verstes (2,476 miles).

AUSTRIAN POSTAL AND TELEGRAPH STATISTICS.—The statistics of postal and telegraph services in Austria, which have just been published by the Statistical Department of the Ministry of Commerce, show that, in 1894, the number of post-offices open increased from 5,299 to 5,466, and the number of telegraph-offices from 4,229 to 4,393. The total number of letters, newspapers, &c., forwarded through the post was 843,100,000, as compared with 705,800,000 in 1893. The number of telegrams forwarded was 12,600,000, of which 5,800,000 were sent to places in Austria, and 5,700,000 were received from, or despatched to, foreign countries; 1,100,000 telegrams were sent free of charge. At the end of 1894 there were in existence 122 telephone systems, and 47 intra-urban connections; the number of subscribers was 16,647, and the length of wire was 64,605 kilometres (40,120 miles): 649,514 telegrams were forwarded by means of the telephone systems, and 27,000,000 conversations took place at call-rooms and between subscribers. The total receipts from the post, telegraph, and telephone services amounted to 37,977,711 florins (37,182,850 florins in 1893), while the expenditure was 34,514,115 florins (34,103,045 florins in 1893). There was thus a surplus of 3,463,596 florins.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 5.—"The Mexican Drainage Canal." By FREDERICK HENRY CHEESEWRIGHT, M.Inst.C.E.

FEBRUARY 12.—"Water Purification by means of Iron." By F. A. ANDERSON. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

FEBRUARY 19.—"Report of the Royal Commission on Secondary Education." By H. MACAN. SIR OWEN ROBERTS, M.A., will preside.

FEBRUARY 26.—"The Standard of Musical Pitch." By A. J. HIPKINS. SIR ALEXANDER C. MACKENZIE, Mus.Doc., will preside.

Papers for evenings, the dates of which are not yet fixed:—

"Dairy Produce." By GEORGE BARHAM.

"Peasant Life and Industries in Ireland." By PROF. HADDON.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Early English Organ Writers." By BURNHAM HORNER.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

FEBRUARY 13, at 4.30.—"Punjab Irrigation—Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab. LIEUT.-GENERAL R. STRACHEY, R.E., C.S.I., F.R.S., will preside.

FEBRUARY 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. TRIPP, formerly of Sumatra. THE MARQUIS OF LORNE, K.T., M.P., will preside.

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

FEBRUARY 4.—"The Garden in Relation to the House." By F. INIGO THOMAS. T. G. JACKSON, A.R.A., will preside.

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S. WALTER CRANE, R.I., will preside.

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

FEBRUARY 18.—"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL (General Electric Company, U.S.A.). W. H. PREECE, C.B., F.R.S., Vice-President of the Society, will preside.

MARCH 3.—"The Commercial Prospects of English East Africa, and British Central Africa." By G. SCOTT ELLIOT. SIR JAMES CRICHTON BROWNE will preside.

MARCH 17.—"The Maories." By H. VOGEL. SIR WESTBY PERCEVAL, K.C.M.G., Member of the Council, will preside.

APRIL 21.—"Madagascar." By CAPTAIN PASFIELD OLIVER. MAJOR MARINDIN, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.

FEBRUARY 3.—LECTURE III.—*The Testing of Transformers.*—The measurement of the power taken up in an inductive circuit—The theory of the wattmeter—The construction and use of the alternate current wattmeter—Various methods of measuring alternating current power—The testing of transformers—Testing by curve tracing—Testing by the wattmeter—Differential testing—Practical tests in the sub-station and workshop efficiency curves—Core losses for various sized transformers—Specifications for transformers—Measurement of copper losses and drop—Iron testing.

FEBRUARY 10.—LECTURE IV.—*The Employment of the Transformer.*—Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs or alternating current stations—Conclusion.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.

February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.

March 9, 16, and Tuesday, March 24.

⁂ It has been found necessary to alter the date of the third lecture to Tuesday, 24th March, instead of Monday, 23rd. The first two lectures will be delivered on Mondays.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.

April 13, 20.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. A. Fleming, "Alternate Current Transformers." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, 4 p.m. Mr. Reid, "Co-operation in the Sale of Farm Produce."

Engineers, United Service Institution, Whitehall, S.W., 7½ p.m. Inaugural Address by Mr. S. H. Cox, President.

Junior Engineers, Westminster Palace Hotel, S.W., 7½ p.m. Mr. H. M. Rounthwaite, "Marine Engineering Design." (Lecture I.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. F. Reid, "Manufacture of Linoleum."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. J. Baker, "Egypt of To-day: Her People and Their Country."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. R. F. Colam, "An Improved Method of Settling Disputes as to Rights of Way."

British Architects, 9, Conduit-street, W., 8 p.m. Papers on "Wood Carving and Wood Carvers," by Messrs. W. H. Romaine-Walker, W. Aumonier, and J. E. Knox.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Hull, "Mount Sinai."

London Institution, Finsbury-circus, E.C., 5 p.m. Colonel Matthey, "The Campaign of Marengo."

TUESDAY, FEB. 4 ... SOCIETY OF ARTS, John-street-Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. F. Inigo Thomas, "The Garden in Relation to the House."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Coverings of Plants and Animals: its Structure and Functions." (Lecture IV.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on "Recent Developments in Gas Engines."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "Second Report on the Reptiles and Batrachians collected by Dr. A. Donaldson Smith on his Expedition to Lake Rudolf." 2. Dr. A. Günther, "A Collection of Fishes made by Dr. Donaldson Smith during his Expedition to Lake Rudolph." 3. Mr. Martin Jacoby, "Remarks on the System of Coloration and Punctuation in the Beetles of the Genus *Calligrapha*." 4. Mr. F. E. Beddard, "The Oblique Septa in Passerines and other Birds."

WEDNESDAY, FEB. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Frederick Henry

Geological, Burlington-house, W., 8 p.m. 1. Dr. Henry Hicks, "Morte Slates and Associated Beds in North Devon and West Somerset." 2. Prof. T. W. Edgeworth David, "Evidence of Glacial Action in Australia." 3. Mr. C. W. Andrews, "Structure of the Plesiosaurian Skull."

Cheesewright, "The Mexican Drainage Canal."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Dr. F. A. Dixey, "The Relation of Mimetic Patterns to the Original Form." 2. Dr. D. Sharp, "The Rynchophorous Coleoptera of Japan. Part IV." 3. Prof. Williston, "The Diptera of St. Vincent."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. Mr. E. Carpmael, "Aiding and Abetting in Infringement."

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, FEB. 6...Royal, Burlington-house, W,. 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. B. J. Cormack, "Polystelic Roots of Certain Palms." 2. Mr. R. Morton Middleton, "A Remarkable use of Ants in Asia Minor."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Tildem and E. Barnett, "The Molecular Weight and Formula of Phosphoric Anhydride and of Metaphosphoric Acid." 2. Prof. A. Hutchinson and W. Pollard, "Lead Tetracetate and the Plumbic Salts." 3. Mr. A. Allen, "An Improved Mode of Determining Urea by the Hypobromite Process." 4. Prof. W. F. Laycock, "An Examination of the Products Obtained by the Dry Distillation of Bran with Lime." 5. Prof. A. G. Perkin, "Luteolin."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Carl Armbruster, "Two Forgotten Italian Masters—Cherubini and Spontini."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. H. F. Frost, "The Art Work of Richard Wagner."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Philip H. Wicksteed, "Dante." (Lecture IV.)

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Evans, "Lincoln Cathedral."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. C. E. Curtis, "Forestry and Agricultural Depression."

FRIDAY, FEB. 7 ... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Hon. John Collier, "Portrait Painting in its Historical Aspects."

Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting. Address by the Psesident, "Some Structural Characteristics of the Granite of the N.W. Himalayas."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, FEB. 8 ... Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albermarle-street, W., 3 p.m. Prof. Hubert Parry, "Realism and Idealism in Musical Art," (Lecture II.)

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FRIDAY, FEBRUARY 7, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Dr. J. A. Fleming, F.R.S., delivered the third lecture of his course on "Alternate Current Transformers," on Monday evening, 3rd inst.

The lectures will be published in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED ART SECTION.

February 4, 1896; T. G. Jackson, A.R.A., in the chair.

The Chairman, in introducing Mr. Thomas, said that the relation between the garden and the house, which was the theme of the paper, was so obvious that it was marvellous how often it was forgotten. Everyone liked a nice house and a nice garden, but it had not been sufficiently considered of late years that the house and garden might react on one another. The site was generally selected by the landscape gardener, then the architect was called in to build a house on a space which had, perhaps, been levelled for him, but which he had not chosen. After he had finished, the landscape gardener returned, and laid out the fountains, serpentine walks, and clumps of bushes and trees, with which they were all familiar. Any intrusion by the architect into the garden would probably be considered as much of an impertinence as that of the gardener into the house would be resented by the architect. Thus there had been no recognised relation between the two, and much had been lost thereby. Occasionally in an old-fashioned manor-house which had escaped alterations, one felt the poetic charm of the scene, and the artistic sense was satisfied by the correct relation between the house and its setting. But it was a mistake to suppose that this completeness could only exist on a large scale. It might exist, not only in the palace, but in the villa or the cottage; even on the smallest scale, there was an opportunity for doing well or ill; either ignoring the house or working up to it, and adding to its attractiveness, or perhaps it might be said in some cases, of mitigating the unattractiveness of the modern villa. Mr. Thomas was eminently qualified to speak on this subject, as he had shown by the work of which he was joint author,—"The Formal Garden."

The paper read was—

THE GARDEN IN RELATION TO THE HOUSE.

By F. Inigo Thomas.

I think, as a nation, we are beginning once more to realise the charm of a formal garden. For the last few decades we have been passing through a period of architectural taste, called the Gothic revival, and, sated with the dry bones of antiquarianism, we are beginning at last to infuse a breath of life into some few of our buildings. And it is natural that the growth of interest in this direction should be accompanied by a wish to give them some proper and dignified setting. Now this is a part of architectural design that has, for rather more than a century, been practically overlooked. In England, up to the time of the Georges, there was still some survival of it, as is evident from the plans of country seats to be found in Campbell's "Vitruvius Britannicus;" but some, if not most, of these schemes were only carried into execution in so far as the main building was concerned. And I think it is not overstating the case to say that, up to the middle of the last century, no architect thought his design complete until the available ground in the immediate vicinity had been considered with relation to the building itself.

For a brief sketch of the history of the subject—in England, at any rate—it is not necessary to go back further than the time of Henry VIII. Up till then the monasteries had been the chief homes of cultured retirement, and of the art-loving world; but, at their supression, the scene changed, and it was in the houses of a nobility, suddenly enriched with monastic plunder, that the arts took refuge. New ideas from Italy and the East found a ready welcome in England, and the seed fell on a good soil for architecture, the courts of Henry VIII. and Elizabeth dearly loving lavish display in that direction. No sooner had the monastic buildings become untenanted, than there began to rise palaces of pleasure all over the land; and their gardens, too, were stately, as befitted the jewels of which they formed the setting. Moreover, with peaceable times, there was no longer the feeling of insecurity that had necessitated a semi-fortified seclusion. The wind was now the only foe to be kept at bay, so enclosures expanded to more liberal dimensions, and delicate grilles of hand-wrought iron made the exits and the entries into courts of green or parterres gay with flowers.

It is one of the drawbacks of this subject that we cannot study the fine old examples under the same conditions as buildings, and I cannot think of a single instance of an Elizabethan garden that has not undergone so much alteration in later times as to be almost unrecognisable. Even where the architecture remains fairly intact, nature has been at work, obliterating the original design by slow degrees.

Here* is a view of the terrace steps at Haddon, which all of you will recognise. Perhaps there are few places that have been so fortunate in escaping the hand of the destroyer. And that is why I have chosen it, for there is just sufficient left to help us in picturing the garden as it was. Anyone who has been there will remember the mysterious gloom under the great yews on the terrace, and will have pictured to himself perhaps the elopement of Dorothy Vernon under the selfsame boughs. But in her day we must remember these knotted trunks were young, and the stones that now lie in disorder about their roots once bordered well-kept paths. In fact this natural wilderness so near to the house was no part of the original intention, and in those days would have been kept further afield. Here is another view as it probably was. The grove that nowadays covers the terrace has given place to a garden, and the great yew trees are shown—as perhaps they were—clipped into heraldic devices taken from the family coat. Against the terrace wall there is a rich border of flowers, and the hedge that skirts the path is trimmed to its original proportions.

A house of the time of Elizabeth was approached through an avenue and one or more courts in quiet tones of green and grey. Out of this rose a stately mass of buildings—two wings and a centre piece—with broad retreating shadows between, sparkling with myriads of small panes set among softly moulded mullions. Through the walls on either hand festooned with a wealth of climbing roses, there would be splashes of sunlight and colour from garden courts beyond, while at the back the brewhouse, offices, and so forth would be screened off from garden courts and orchards by walls of ample height. This view of the forecourt at Canons Ashby will serve as an example, but the type was infinitely varied.

If there is one thing that was more characteristic than another of the pleasure grounds of the past, it was this system of enclosure and subdivision, and to my mind when that was abandoned the main charm of the old English garden vanished. Sir Walter Scott once raised his voice in lamentation over the destruction of an old garden he had known as a boy, and perhaps you can each remember some old world pleasaunce falling into the hands of the modern landscape gardener. I have vivid recollections of just such a garden as Sir Walter describes. It lay on the hillside by an old house in Yorkshire. In the first court as you entered from the shrubbery were beds of brilliant flowers cut out in patterns like a ceiling in the house, and against the south wall were vineries of black Hamburghs and dark mysterious potting-sheds. Then there was the bowling-green, a wide expanse of velvet turf with banks and terraced walks all trim and neat, where apricots and nectarines ripened on the walls. And one side was fringed with scarlet lychnis and sweet williams, where the red admirals and tortoise shells would spread their wings in the sun all day. Then there was the summer-house with a racing fox for a vane, and bowls in a corner cupboard; an apple house, where the old gardener was always at his best; and last, but not least, Peter the Great's arbour, for there, in defiance of history, tradition had fixed the spot of the Czar's proposal. But an evil day came when the quiet retirement of this unoffending paradise was invaded by the "Landscape Gardener." The walls were thrown down, the terraces destroyed, and the whole converted into a wilderness of specimen shrubs, for this was the new ideal that had taken the place of the old.

But to return to the time of Elizabeth. It was foreign to the idea of a garden to allow forest trees within the walls. The grove had its place, and that was outside the garden enclosure, where a lofty cliff of green would be more than welcome as a background to fruit and flowers. This view of the garden at Montacute serves to explain my meaning, although the original treatment was rather different from what is shown in the drawing. And it was probably from a wish to obtain a background of even tone that hedges first came to be trimmed. This trimming or pleaching, as it was called, which seems reasonable enough on these grounds, was eventually carried to absurd lengths. They had felt the need of single yews to mark the salient points in complicated patterns of flower beds, and these they cut into a variety of forms ; first into cubes and obelisks, and then by degrees into every shape that fancy might suggest, until at last the repose of the garden was as much hampered by verdant sculpture as Westminstsr Abbey is with its monuments. The garden at Levens, though beautiful in colour, is perhaps the most striking example of this vagary. And since, of course, to keep the yews in shape requires considerable labour, it is hardly surprising that there should be few of the kind remaining. There are one or two rude bits of pleaching at Barncluith in Scotland, and a touch of quaint humour in the gardener has caused him to fashion a whiskey still under the prominent nose of a Scotchman in a Tam-o'-Shanter hat. The French influence that was always more evident north of the Tweed, is traceable in the garden-house, and its curious spiral staircase is an arrangement that I have not seen elsewhere. Green vaults or tunnels of yew are sometimes to be found, and that at Melbourne now forms a rich tangle of intertwining branches, as may be seen from the illustration.

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* The references in the paper are to the views thrown on the screen by the lantern.

As I have said above, old gardens were divided into several departments, and each of these bore a character distinctly its own. There was the parterre or flower garden, with its fountains, and flower-beds in geometrical designs of box. The bowling-green with its garden-house and shaded seats. The fruit orchards, wilderness, and so forth. Now someone has described personal charm as an open secret, and that is precisely the character of an old garden. There is more left to the imagination where the whole cannot be seen at a glance. Change of level was another means of gaining effect. The eye is so used to the appearance of things from the ordinary point of view that even a slight elevation presents the scene in quite a new light. In this view of Kingston - house, though the arrangement of the terraces is sufficiently interesting in itself, still the novelty of the position is mainly due to the point of view that has been chosen for illustration. So conscious of this fact was Turner, the landscape painter, that he habitually raised the point of vision in his picturos to a higher level than was really possible. Anyone can test this for himself by standing before an object that Turner has painted, and an instance, within reach of any Londoner, that occurs to me at the moment is the old house at Mortlake, of which there was such a subtle rendering in the exhibition of old masters last winter. This house and garden still remain pretty much as they were when the great painter drew his poem from them.

There is always a charm in length of vista that could not have failed to appeal to garden designers. And to give point to the long perspectives that were planned to pass through house and grounds alike, they were adorned at intervals with fountains, statues, or other objects of interest. Each of these would form the centre of a network of cross vistas so that sunlight or shadow, front view or profile, should offer the scene afresh as often as it was approached from a new direction. As a simple instance of this we may take the somewhat mutilated fountain at Bolsover Castle. This stands at the intersection of two alleys with hornbeam hedges on either side. Seen from here it appears a bright object against the curtain of trees and ruined gables of the banqueting-hall. The next alley to the left would give it in a harmony of soft greys, with the grim walls of the castle keep in the background. And here is a view in the grove at Melbourne. This belongs to a later date when more attention was being given to groves and bosquets, and the architectural principles that had formerly been confined to the garden proper were creeping farther afield, as will be seen by the fountains and hedges further down the glade. This vase I may mention is one of the finest examples of lead-work in England. There is one at Drayton that may be nearly as fine, but I have never had an opportunity of making a drawing from it.

When large sheets of water came to be included in the dressed grounds they too were treated in the same formal manner. The most ambitious efforts in this direction were probably of Dutch origin and due to the same energy and skill that made the canals and huge drains of the Fen country. Here are two instances from Wrest, in Bedfordshire. A **T**-shaped piece of water some 400 paces long with broad turf verges next to the groves—and the fish pond in a secluded spot in the wood among yew hedges that are now some 20 feet in height.

The development of garden design may be said to have been the elaboration of these few principles, for the object of the old-time designer was to make a stage on which to play the drama of every-day life, but unlike the stage the scenery was real, and the acting an unaffected pleasure in existence, and in the sights and sounds and scents of nature. Difference in locality has, of course, necessitated difference in material, and according as brick or stone was more ready to hand, so the character of the work was restrained or free in its treatment.

Perhaps the period of greatest activity may be placed in the reign of William and Mary, for to that time belongs the English classic on the subject, a fine folio of views drawn by Knyffe and engraved by a fellow-countryman of the name of Kyp. Then we have the diary of Celia Fiennes, a lady who spent some years riding about England and taking a lively interest in the improvements that her many friends and relatives were making to their country places. And to this time too belong the great schemes of Wren's devising for the beautification of Hampton-court. But with the progress of the 18th century interest seems to have declined. People perhaps began to tire of spending the sums that their great schemes must have needed to keep up. Pope struck a note of ridicule, and the stupidity of a decadent age was ripe to hoot them out of fashion. Then came the opportunity of the landscape gardener. Kent and "Capability" Brown stepped on to the scene, and though they mowed down avenues and destroyed every vestige of dignity under the pretext of "helping nature," they seem to have forgotten how to make a garden. They again were followed by Repton, Sir Uvedale Price, and a host of minor imitators, who were glad enough no doubt to have found a profession for which no previous training appeared to be necessary. To my mind the finest corrective for insanity in design is a knowledge of what great architects have done in the past, and that is what the landscape gardener always seems to have lacked. Nothing can be more childish than their attempts in this direction, as we all must admit on turning over the leaves of any book on the subject from Humphrey Repton down to the present day.

On looking back, one cannot help thinking that the change in popular feeling had more to do with expense in the maintenance of an overgrown formality than with the temperate verdict of thoughtful men, for by far the greater number of old English gardens that have come down unaltered to the present day lie before the cottage doors of the labouring classes. Now there is a remark that one often hears, and which always betrays a certain apathy on the subject, namely, that a formal garden is well enough for a formal house, but a natural garden is more in keeping with houses of the present day. This implies, firstly, that nature has no place in a formal garden—an illusion that a visit to any old garden would soon dispel; and secondly, that buildings are not essentially formal when it would appear that squaring the first stone or moulding the first brick was the outset of a formal principle that must necessarily continue throughout. With few exceptions, the reign of Victoria has seen wildernesses—more or less neatly kept—pass for gardens. Sir Charles Barry made one or two formal arrangements to the houses he built, but they were a good deal borrowed from Italian instances, and not at all in harmony with English traditions, so much better understood by Nesfield and Devey a little later. There is a popular superstition that all formal gardens in England were either Italian or Dutch; very much on the same principle, perhaps, that all pen drawing is called etching by the casual observer. Now Italy, no doubt, supplied us with many ideas on this subject, as also she did in architecture, but the buildings that rose under Italian influence in Tudor times were so English in feeling, that we have had to call them "Elizabethan." And so it was with gardens, the English tradition coming out so strongly as to render them markedly different from Italian examples. Here is a view of the back of a terrace with two pavilions, in which there is no trace whatever of Italian influence. The octagon form, the battlemented parapet, and the shape and mouldings of the windows, are all true Gothic work, from which it would seem that English gardens were formal in design before the arrival of ideas from Italy.

But since Italy is generally accepted as having been the main source from which we drew our inspirations, it may be of interest to look for a moment at what was being done in that country at the time of which we are speaking. A year or two ago I attempted to make surveys of some of the Renaissance villas in the neighbourhood of Rome. But from the very dilapidated condition in which I found them, it has been no easy task to piece together the various remains; so I hope you will excuse their incompleteness on this account. I do not propose to give them in any chronological order, but merely to draw attention to points in the design that may seem to bear on the subject of this paper.

Generally speaking, the sites chosen by the wealthy cardinals who erected these villas were on rapidly falling ground well above the fevers of the plain. And the boldness with which they modelled and carved a mountain spur to suit the whims of their architect was truly heroic. This is well brought out in the villa Mondragone, at Frascati. You can see by this survey that the whole scheme of buildings and surroundings was planned so as to fall on four successive levels. A centre line can be imagined running through from end to end on which fall the principal features, and a certain symmetry is observed on either side of it, for in architectural design symmetry has always been the rule and irregularity the exception. It is noticeable too what pains were sometimes taken to preserve this balance even in the most difficult situations. The approach from the road to Colonna, some 600 paces long and bordered with lofty cypresses, parts opposite a fountain in the foot of a great cliff of masonry, and climbs by means of *pentes douces* to the first terrace. This in itself is a rise of 55 feet, and since the original fall of the ground was in a diagonal direction a great deal of masonry was required to bring one end of the terrace to the necessary height. At four points in the parapet there are massive banded columns each bearing on its summit a slender iron cross. These four huge sentries stand out against the sky and the olive-clad hills with magnificent effect, but their *raison d'être* was not quite so evident until it was found that the great vaults, on which the terrace is supported, were once the palace kitchens, and two at least of the columns were nothing more than ornamental shafts to carry the smoke clear of the windows. This terrace was probably paved throughout with *palombino,* and used for the reception of magnates with their retinues from Rome. But there seems to have been a garden under the palace windows on ground that rises gently to the level of the main courtyard. Here the buildings lie on three sides of a court planted round with rows of elms, the fourth side being divided by a high niched wall from the Privy garden. This was laid out with plots of turf in borders of flowers, and two circular fountains in the centre. A fine arcaded loggia by Pouzio fills one end, and raised on a terrace opposite is an amphitheatre of inlaid marble fountains. From here a door and flight of steps lead back to the main court entrance, and opposite this a wealth of flowers borders the foot of a great bastion wall that supports the bosquets and vineyards at a higher level still, that is to say about 150 feet above the level of the avenue. There is one curious thing about this plan that I am omitting to mention, and that is the small garden that lies on the roof of part of the building at about the same level as the great court of the palace. You can judge its position better perhaps in this view of the fountain, where a portion of the balustrade appears to the left of the picture. And here is a view of the great terrace, with the fountain and two of the columns mentioned above. The tops of the cypresses in the avenue are just visible over the parapet to the left.

This survey is of a very anomalous scheme at the Villa Torlonia, where no two of the principal objects fall in a line. There are all the features that one is accustomed to find in designs of this kind, but no two are related. The house and forecourt are placed in a corner of the ground, and at right angles to the terrace. There is an elaborate arrangement of travertine stairways, among rose gardens, leading to the terrace, but here a fresh centre is caught up and carried through the groves of ilex to a wide range of fountain niches supporting a second terrace. Thence, by winding stairs and basin upon basin of gushing water, one reaches the heart of the wood; and here a circular clearing, with seats at intervals, and a fine fountain pool in the centre that supplies the cascade below. The Italian designer always seems to have made the most of this reservoir, in which the water was collected from the hills before passing on to the various fountains; and since they are often at some distance from the rest of the work, one comes upon them as an unexpected pleasure.

This is a view in the grove at the foot of the cascade I have just mentioned. The cascade itself is hidden among the trees to the left; but here is the front view of a somewhat similar arrangement at the Villa Aldobrandini.

This is a very incomplete survey of the Villa d'Este at Tivoli. It was the work of Pirro Ligorio, about the year 1550, and is so elaborate in its many details that, to do more than touch on it to-night would exceed the limits of this paper. The garden is bounded on three sides by the town of Tivoli and the d'Este palace, and the fourth looks out over a network of vineyards to the distant campagna. From the palace, which lies along the terrace to the right of the survey, the ground falls with great rapidity for about a third of the distance, and then more gradually to the centre of the garden. At about this point it reaches the level, and is crossed from end to end by three oblong pools, which divide the garden proper from the grove. Here is a view down the length of the pools. The building over the cascade at the far end is the case of a water organ, which, by the way, was not an unusual adjunct to the garden in old days. This is a nearer view of the organ case, and what I want you specially to notice in these views of the Villa d'Este is the determination of the designer not to be cheated of his effects for want of sound and durable material. All the structural parts of this garden are built up of rough bricks, mortar, or concrete, and covered with plaster of various textures, and in the more finished parts with delicate modelling in *gesso*, or a rough mosaic of coloured marbles. Now nothing could well be more at variance with the methods of the English workman at the time of the English renaissance. He would have far rather sacrificed his effect than gain it in a mean material, and the frank dissimulation of the Italian character was something altogether beyond his understanding.

Here is part of a crescent-shaped flight of stairs encircling a fountain, and this is a row of ninety jets that spans the width of the garden, with ninety panels of modelled figure subjects from Ovid's metamorphoses, under canopies and heraldric devices. An equal number of masks pour water into two long channels, one above the other, as seen in the photograph; but all this is now so much covered with soil and moss, that of course it is rather difficult to judge of its original effect.

So much for the Villa D'Este. And now let us visit a spot some forty miles from Rome, where perhaps the most perfect example of a regular type exists in the Villa Lante. Here the gentler fall of the ground has necessitated no great departure from symmetry in design. There are five separate levels, and each of these is marked by some quaint conceit in arrangement. All the main objects of interest lie on the centre line; or if, as in the case of the Casini, they are duplicated, they are plotted at equal distances from the centre.

The lowest level is given to the parterre, a court of 100 paces square enclosed in high walls and tall box hedges. The flower borders re-arranged in elaborate patterns of clipped box as shown in the upper half of the plan. In the centre is a square pool of about 50 paces, with stone parapet and obelisks at intervals. From the middle of this rises a grand fountain of several storeys, crowned by a group of lions and youths supporting the crest of the Montalti. A number of jets play from various points in the fountain, and what with the brilliant colours reflected in the surface, the gentle plashing of the water, and the delicate scent of flowers, no more delightful spot could well be imagined. The house — or "casino" as it is called—is divided into two parts with loggias opening on to this court, and staterooms level with the next above. Here stands the candle fountain, a circular structure of rather curious design, but of which I have no photo to show you. There are rows of fine stone vases to right and left, under the shade of the plane trees, and handsome flights of steps lead up to the next level. Here the centre of a plot of turf, with groves on either side is taken up with a massive stone table. We are looking down the length of it in this view, and you will notice there is a watercourse all down the centre. In the heat of an Italian summer, one can well imagine the luxury of such a table for dining in the open air. At the end of this court is the giant fountain, so called from the colossal stone figures on either side of the basin.

Leaning over the balustrade in the centre you can see what will be clearer in the nex view, namely, the claws of a large stone crayfish. Now the Villa Lante was begun unde Cardinal Gambara, and in punning allusion t his name, Vignola, the architect, introduced watercourse in the next court, composed of chain of the vertebræ of this animal. It is al in stone, of course many times the size of life and this idea shows a playfulness in Vignola' character that, judging from other works, on would hardly have suspected.

This is a nearer view of the giant fountain Rather faint, perhaps, as it was taken at sunset. And the next is looking back at th stone table. Over the balustrade, at the fa corner of the court, you can catch a glimps through the trees of the roof of one of th casini.

This is the upper end of Vignola's chair where the water issuing from a flight of step begins its course down the body of the crayfish.

The next view is taken across the uppermos court, and shows part of an octagon fountai that fills the centre, and is surrounded b stone seats against a hedge of box. Yew, by the way, is hardly ever used in Italy, as far as I could discover. The sides of this court towards the grove are lined with balustrades and graceful stone columns, that have lost their original purpose, but still look extremely well against the deep green of the ilex.

This, and a similar pavilion, flank the central recess that terminates the garden, and forms a reservoir for supplying the various fountains.

Of all the Italian gardens I have visited, none can compare with the Villa Lante for so much beauty in so small a compass, and I could have wished to show you a view of the lowest court, which is by far the finest, but minor regrets are useless when we remember that photography denies us the charm of colour, on which, after all, a garden mainly depends for its beauty.

The chief points to be noticed in these Italian examples are the boldness of the terracing, the quantity and elaboration of the stonework, the ingenious arrangement of fountains, and lastly, the absence of wide lawns, that give the distinctive character to English gardens. At the Villa d'Este, the materials employed are hardly worthy of so great a work; but at the other three villas I have mentioned, stone is used. At Frascati we find the Travertine that is quarried in the neighbourhood—a tawny yellow stone something like Ham Hill, and at the Villa Lante the whole of the stone work is a dark grey green speckled with black scoriæ. This is called Peperino, and is quarried in the hills round Viterbo. It takes a soft white lichen when dry, but under the spray of fountains or in any damp situation it is hardly to be distinguished from bronze.

Before leaving Italy, where perhaps of all countries the treatment of stone or marble in connection with water has received most attention, I should like to show you an instance from the Boboli gardens at Florence. This is an oval lake with an island in the centre. It is rather late in design and is surrounded with balustrades and white marble figures of considerable beauty, but there is a certain want of background or depth of colour in the trees that surround it, so that to see it at its best it should be visited towards evening when the shadows are lengthening. Except for this piece of water the Boboli gardens are to my mind much overrated.

For unpretending charm this small stone *arca* in the flower garden of the Villa Aldobrandini is difficult to equal. Some of you may remember the exquisite drawing that Mr. Elgood had made of this in his exhibition of "Gardens in many lands" last Spring.

There is something inexpressibly sad in the ruin that has stolen over some of these villas. The stately buildings are tenanted by a few contadini and vines usurp the paths that once were swept with the robes of cardinals. On the terrace at the Villa Falconieri this solitary figure rises from the parapet a silent witness of the gradual decay that is going on around him. In the far distance the grey dome of St. Peter's seems to smile defiance at time, and crowds throng the Corso as densely as ever—but here among the scattered fragments at his feet the lizards that climb and blink in the sunshine are all that is left of the gay assembly that once gave life and colour to the garden.

With this we may bid adieu to Italy and return once more to England. So far we have been dealing with the history of the past, and now let us pause for a moment to consider what prospect there is of this branch of art taking root again to flourish amongst us in the future. There are no doubt many discouraging influences at work to paralyse the efforts of those who would have fine gardens. The general inclination is to procrastinate, awaiting the settlement of social problems that never seem to come nearer solution. And the comparatively recent development of the railroad system has brought dreary villadom in its wake, as well as a fever for travel, that sadly interferes with the contented enjoyment of home life. Perhaps, as time wears on, people will begin to realise that, of their country neighbours, the most contented and happy are not by any means those who spend a large portion of every summer toiling, guide book in hand, through continental towns. I have a suspicion that the characters we know in the works of Jane Austen or of Charlotte Brontë drew far more of the real essence from existence than we do, and yet they were stay-at-home people; and perhaps it is only in a country community where people are at home, and at home with one another, sharing their joys and sorrows, and exchanging small kindnesses, that the reality of life is to be found. Here, in our huge metropolis, the half or more of each man's life must almost of necessity be a closed book to his neighbour; but, on the face of every old garden or building is written the story of lives knit up with each other in a way that is hardly possible in the hurry of modern existence. And behind all this lies the decay of honest sentiment that is, to my mind, one of the saddest features of the age.

However, there is another and a brighter side to the picture. For my own part I have been made conscious of a tendency towards revival among a certain class in the country, by their having allowed such gardens to be added to the buildings I have designed for them. Here is a drawing of one in Dorsetshire, that has been finished and growing into shape some three years or more. The house was of various dates, mainly from Edward VI. to Elizabeth, but with other additions down to the present century. The wing to the left, and that containing the dining hall, it was decided to leave untouched, but the comparatively modern work in the south and right wings is shown in the drawing, rebuilt on the same lines as the older portions. The site of the present gardens was a grass field, falling somewhat from left to right. There were a few trees here and there, and a larch plantation across the windows of the south front. The high road bounded the ground on the left, and a back drive skirted the near side of the field, and continued behind the grove to the back of the house. When the ground was cleared of trees and the roots grubbed up, the soil from the south garden and pool was excavated and removed, to form the terraces round the sunk garden. Lines were laid down to make vistas through the centres of the courts, and sundial, fountain, or wrought-iron grille placed where most they seemed to be needed. There are three main lines on which the work is planned. One from the south garden gate in the foreground, catches the reflection of the house in the long pool, passes through the doorway in the south front, and out into the court beyond; thence between the piers that are just visible above the roof, and so down the centre of the tennis lawn, and across the pool at the end to the sculptured figure in the yew hedge by the river. Another line, centring with a window in the left wing, passes down the rose garden and through the circular coronet to a niche fountain between the two arches in the foreground. The third is taken from a summer house in the grove to the right, across the south garden, through the coronet and up a flight of steps, with a wrought-iron gate, to the sunk garden. Here it catches the fountain and continues up another flight of steps to end in a stone seat that projects from the back of the terrace. The water for the fountains is forced up by ram in the river to a couple of tanks in the roofs of the pavilions, which gives it a fall of about twenty feet to the long pool in the south garden. All the stonework, with the exception of a little Doulting, came from the Ham Hill quarries. It is a warm rust-coloured stone, taking a grey lichen, and I have tried to embody some of that variety in the walling that makes such a marked contrast between the old work and that done at the present day.

This is a plan to scale of the general arrangement. It does not take in quite all the work shown in the bird's eye view, but it may serve to explain some of the points that were not quite clear in the last—for instance, the planning of the grove to the right and the central vistas, which are laid down here with dotted lines.

This is a view of Barrow Court, in Somerset. The place belongs to Mr. Martin Gibbs, who has been plucky enough to carry out the work on a scale almost approaching the boldness of older examples. Nearly all of what is seen in this drawing is now *in situ*. That is to say, the large stone vases that complete an architectural arrangement at the far end of the central alley were hoisted into position last week. A semicircular balustrade with twelve figure terminals is to take the place of the plain walled bastion in the foreground, but with that exception it may be said to be pretty much as drawn here. I do not mean to say that every feature has been built exactly as shown, for in all such undertakings many drawings are made for every part, and here, for instance, the copper roofed pavilions at either end of the park wall have been built on the square with stone roofs and finials according to a later design. And the gateway at th far end of the grove has since given way to circular recess for a figure with flanking pier and ornaments. You will notice two walle suntraps, one at each end of the terrace That at the further end is furnished wit hooded seats and a stone table for *al fresc* teas, and set round with shrubs at intervals The nearer one has an oak arcading on tw sides supporting a lead roof, and I hope will be a tempting spot for an easy chair an a novel. I should explain that the church an the house—of which a few gables appear o the right—are not my work. The house wa originally Elizabethan, but they have bot undergone a drastic restoration at the han of Mr. Woodyeare, that has on the who made them as good as new. I should hav much liked to show you a fine scheme gardens that was prepared some years ago for Lord Eldon, by Mr. Belcher, the architect, and capitally drawn in birdseye view by Mr. Beresford Pite. How much of this was actually made I have never heard, but there is, I am told, a garden to one of the houses in the Regent's-park which has been carried out on formal principles from designs by Robert Weir Schultze.

All this is very hopeful and refreshing. And now I will show you a sheet of drawings for a small place in Yorkshire which will give, I hope, as clear an idea of the method of procedure as anything I can instance. There is a rule of exhibition at the Academy that forbids more than one drawing being mounted together in the same frame. But in order to explain a building on paper an architect will be anxious to show it in every aspect, both to scale and in perspective. Accordingly, I attempted in this case to fuse the various drawings into one whole, and thereby avoid the Academy rule. It was allowed to pass, but this explanation must be my apology for the confusion of ideas that it exhibits. Here is a ground floor plan of the house. The front entrance is on this side, and there is a straight view down the passage and through glass doors on to the terrace. Here is a plan to a smaller scale of the gardens and general arrangement of the grounds. Two rows of poplars line the carriage drive to a circular walled forecourt and central fountain. Here is the house in block—the stables to the left and walled portion to the right. On the south side of the house a terrace stretches right and left, and returns with crescent-shaped ends to a pair of garden houses that overhang the river. A central flight of steps leads down to a level lawn some 10 feet below this terrace. It is ornamented with a sculptured figure at either end, and railed off from the river between the two pavilions.

It is well, of course, in choosing a site, to depend more upon the masses of foliage that already exist than on what is proposed to be planted, for then the greater part of the effect will not require the lapse of years for attainment. But there is a difficulty at the outset that stands in the way of all such undertakings, for the age of the landscape gardener, from which we are only just emerging, has left an impression that promises to die hard in the mind of the employer; and that is, that a different hand is required for the grounds to that which designs the house, and, furthermore, that it is time enough to consider the grounds when the house itself is finished. Now what I contend is this—that if an architect has such a limited experience of country life that he cannot be entrusted with the grounds, he certainly will not be competent to design a livable home in the country. Also, that to place the whole of the designing in the hands of one individual is the only means likely to result in a harmony.

Now, some of you may have expected, in a paper on gardens, to hear more than a passing allusion to flowers and their culture, for surely that is the end for which a garden is made. I can quite sympathise with this feeling, but, at the same time, I think it arises from the common confusion of horticulture with design. The one is the business of the gardener, and the other of the architect. Similarly it is the business of the latter to design the structure of a building, but excepting, perhaps, within wide limits, he cannot enter into details of furnishing: that must be left to the occupant.

In our towns, and especially in London, where the value of land is prohibitive to most private individuals, the question is mainly one of public pleasure grounds, and the arrangement of streets and squares, so as to set off important buildings to the best advantage. In this the London County Council has done something, and, from what we hear of the proposed boulevard in Marylebone, it appears to be anxious to do more. If this scheme is to be carried out, it will be at the sacrifice of whatever individuality is displayed in the gardens that now border the Marylebone-road. But since many of these have long ago degenerated into mere advertising warehouses, perhaps that is not much to be regretted. By the new arrangement we should gain a fine avenue of trees, and perhaps some colour in borders of flowers between them. But there is a regretable tendency, in municipal gardening, to multiply plots of flowers of uniform colour and size, such as we see in Hyde-park. They are, no doubt, a capital lesson in botanical Latin, and very often their fragrance is delightful, but they would seem to be there not so much for simple enjoyment as for scientific study. To discuss what might have been done in this direction, and what it is still possible to do in London alone, would form ample subject matter for another paper. It has engaged the attention of Evelyn and Wren in the past, and let us hope that those to whose care the future dignity of our capital is entrusted, will be imbued with something of the same spirit that guided those master minds.

DISCUSSION.

Mr. H. H. STATHAM thought the fact of such a paper being read was an indication of the revival of interest in formal gardening which had recently occurred. Mr. Thomas had not treated the old school of landscape gardeners as severely as he might; he might have referred to their proclivities for inventing winding walks and then putting shrubs for them to wind round; and one of the most delightful things he had met with in books on landscape gardening was the direction to plan the entrance near a corner of the high road with a straight elbow from it, so as to look as if the high road led straight up to it. Since reading that, he had been amused, in going about the country, to observe how often the advice was followed. He quite agreed with the general position that the house and garden were inter-dependent, and that the portion of the latter which was closely connected with the house should be formally laid out in direct relation to the architectural features. Still, he would ask whether there was not a little too much antiquarianism in the line which this revival of formal gardening had taken. Clipped trees, for instance, had been brought up again, not, indeed, in such fantastic shapes as those in the Levens gardens, but he understood Mr. Thomas to recommend the use of trees cut into pyramids and obelisks. He did not say he positively disliked this kind of thing, but it was a question whether that was quite the right way to treat trees, and whether they looked as well in winter in an inclement climate as they did in Italian gardens in the summer. A photograph had been shown of the terrace at Haddon-hall in its present condition. and then a representation of what it was originally, and he must say he liked it better in its present state, where you had the balustrade marking the architectural line, but the trees gave a charm and a nice shade. He thought you might carry out a formal design in the whole garden and yet leave the individual trees untouched. He shared Mr. Thomas's contempt for "Capability" Brown and others, but thought he had been rather too hard on Repton. He was a man who ought to be treated separately; his faults were those of his time, and he came very near being a genius; at all events he was very clever, and his book contained many hints, which if you got rid of the bad taste of his time, showed him to have been a very observant and thoughtful man. He was free from bigotry for his day, and when everyone was going in for what was called English gardening, all irregularity, he positively refused to take away an old symmetrical terrace; he acknowledged it was not in the taste of the day, but he refused to admit that gardening was a thing which ought to change with the taste of each generation, He believed it was an error to suppose that a pleached hedge meant a clipped hedge, though he understood Mr. Blomfield was responsible for the literary portion of the book published jointly. He had discussed the matter with him, and thought he had convinced him by quotations from Shakespeare and other old authors that it meant "thickly woven," and that it was used in that sense by Tennyson.

Mr. EVERARD GREEN said there was one very fine old garden which seemed to have escaped notice, at Ascovy-hall, near Spalding. It was a regular Dutch garden, and an old house and lake, and everything remained *in situ*, almost untouched. It was laid out in the reign of Queen Anne, and had been kept up in the most perfect manner. There was also an ancient garden at Sutton-place, near Guildford, which had still the most wonderful remains. It was very fully described in Mr. Harrison's book on Sutton-place.

Mr. HARRISON TOWNSEND said it was quite a pleasure to hear an expert and professor of any of our arts and crafts who was not pessimistic, and who did not regard his art as being absolutely without a future. It might be of some little help to the cheery view Mr. Thomas took to mention that even on the Continent an appreciation of English gardening, and also of English architecture and decorative art was beginning to find place. It was within his own knowledge that in two or three cases of houses which were being built in Germany, the whole of the interior treatment, as well as the general design, were in English hands; and the German proprietor felt that it would not be doing justice to it unless he followed the line indicated in the paper, and entrusted the exterior treatment of the residence and its environment to the same hands; and though there were certain German characteristics, the whole laying out of the formal garden, the natural garden, and the kitchen garden were mostly on English lines.

The CHAIRMAN, in proposing a vote of thanks to Mr. Thomas, said he might be congratulated on having been able in his own practice to realise some of his own ideas, a good fortune which did not fall to the lot of every architect. It occurred to him during the reading of the paper whether the formal garden should not be on rather a small scale. One saw every day, in the laying out of new streets, &c., the mistake people made by drawing things which looked well on paper, but which, owing to the scale on which they were carried out, lost a great deal of the intended effect. Regent-street was a familiar instance. It consisted of a succession of palaces with long extended fronts, with centres and wings; but not one in a hundred who walked down it ever noticed these. With regard to formal gardens, there was a tendency to design geometrical forms, alleys, and vistas, without due reference to the effect of the scale. It seemed to him that they should not be too big, or you would lose sight of that symmetrical arrangement which it was intended to express. With regard to the extravagant designs seen in some old gardens—clipping of hedges and so on, though they were sometimes quaint and picturesque, they did not want to revive these;

but everyone must admit the beauty of a well-clipped hedge of yew, holly, or box. Those who remembered the beautiful exhibition of Mr. Elgood's, last summer, would recall the lovely gardens, chiefly in Northamptonshire, at Rockingham, Bewick, and some other houses, where everything was enclosed in hedges of yew or box, clipped into walls and alleys with the most charming effect. Probably Mr. Statham would not object to that. It seemed to him somewhat parallel to the case of the treatment of foliage in decoration and architecture, as they had to train foliage in capitals and friezes into conventional forms, and stiffen them to suit them to the place they were to occupy, so in a garden they might fairly cut and trim nature into something of a formal shape very different from that which pleased one in the wildness of the wood.

The vote of thanks having been carried unanimously,

Mr. THOMAS, in reply, said he had referred to single trees rather as a necessity for marking the points in a complicated design, and the reason why they should be clipped was simply that the architecture did not grow, and the tree did; and unless clipped, it would grow out of scale with the architecture. For instance, take the two fine cedars seen over the top of the wall in the forecourt in one of the illustrations; they were planted quite small, one on either side of the central steps, but now they were grown to huge trees, so that from the bottom of the garden you could not see the house at all. They ought to have been cut down and replanted after about 40 years. He had been a little loath to include Mr. Repton in the list he gave, but he thought the late Mr. Sedding, in his book, said rather too much about him; and a fashion had been set of overlauding Repton. He had his folio book, and there was a great deal in it which anybody of taste and knowledge at the present day would be ashamed to publish. He did not think it was altogether an excuse to say that his faults were the fault of his time; at any rate, it was no excuse for the time if it was for the man. As to pleaching and its meaning he could not altogether agree with Mr. Statham, and he should be very much surprised to find that Mr. Blomfield was convinced that pleaching was not clipping but interweaving of boughs. The book was the result of a series of talks between Mr. Blomfield and himself, and they went to some trouble to look up the actual derivation of the word. They found that to "plash" was to interweave, and plashing and pleaching were not to be confused. Any gardener if you asked him for a pair of pleachers would not give something to intertwine boughs but something to clip with. Ascovy-hall was mentioned in a book which had recently come out by Miss Tyssen Amherst, published by Quaritch, and contained views of it. Sutton-place was described by Harrison, and the garden was illustrated. With regard to scale, he believed the only thing was to measure the old work, which unfortunately did not exist in these matters as it did in architecture, because they were dealing with things which grew up and disappeared. Failing that, the only way was to design and experiment. It was a thing in which they had vast experience in the old days; and he long ago came to the conclusion that out of doors all measurements were paced, and never measured by rule. It was his experience that, if you paced an old avenue, the widths would fall into fives or tens of paces. At Windsor, for instance, they fell into tens. This rule held equally on the Continent.

NINTH ORDINARY MEETING.

Wednesday, February 5, 1896; SIR WESTBY B. PERCEVAL, K.C.M.G., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bird, Arthur George, Ellerslie, Roath, Cardiff.
Henderson, John McClelland, Ph.D., Glendon, Kingswood-road, Norwood, S.E.
Jonas, Alfred C., Fairfield, Poundfald, near Swansea.
Parfitt, George John Tom, The Avenue, Keynsham, Bristol.

The following candidates were balloted for, and duly elected members of the Society:—

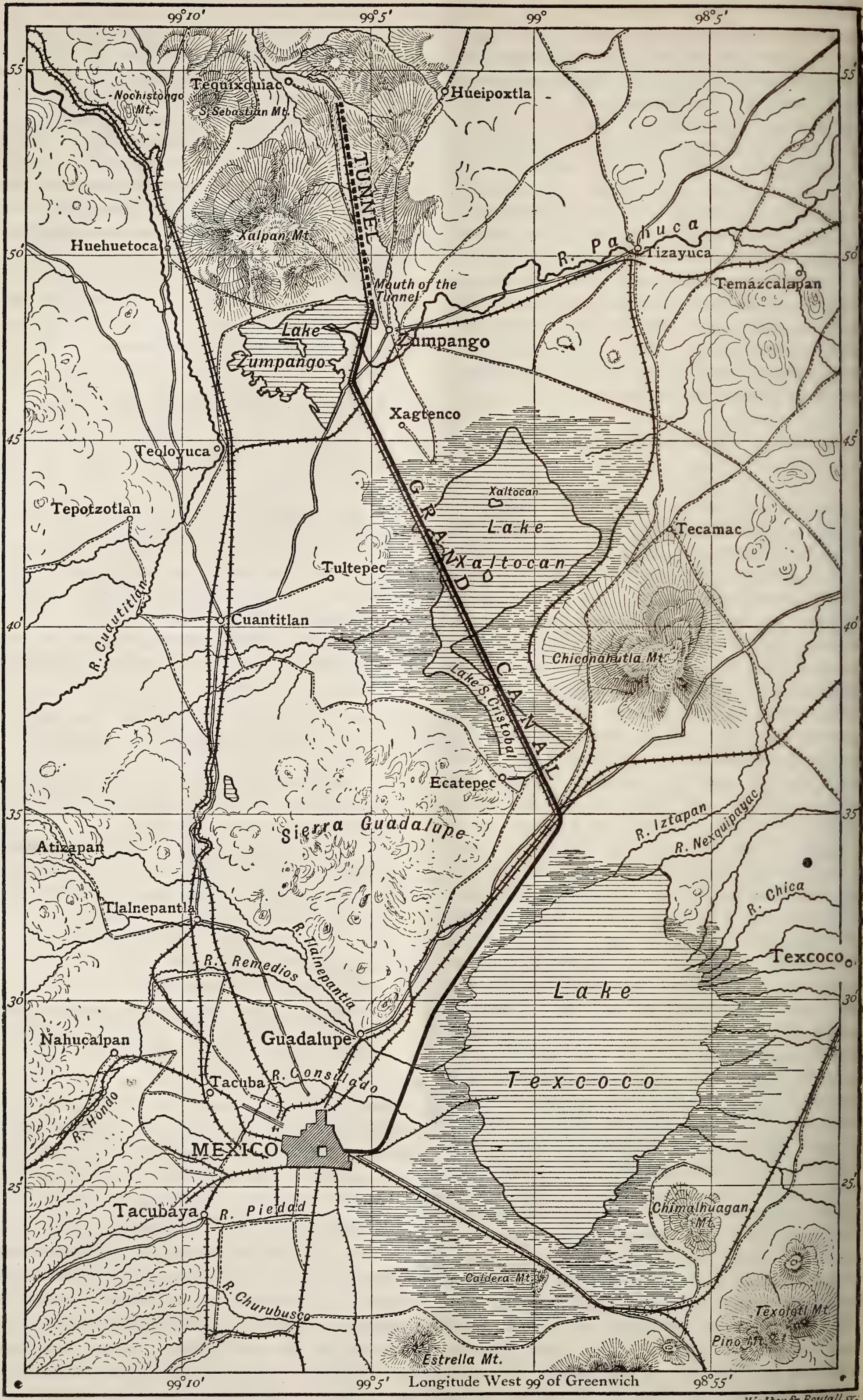
Bale, John Henry Fooks, Lynmouth, North Devon.
Keith, Nathaniel Shepard, Sandycroft Foundry, Hawarden, Chester.
Leckie, Charles Stuart, Borneo Company, Limited, 28, Fenchurch-street, E.C.
Mowat, Magnus, Pitmain-lodge, Granville-park, Blackheath, S.E.

The paper read was—

THE MEXICAN DRAINAGE CANAL.

By FREDK. HENRY CHEESEWRIGHT, M.Inst.C.E.

The drainage canal of the plain of Mexico—one of the most important engineering works ever attempted—is on the eve of completion. The numerous difficulties that beset it from its inception have been surmounted, and about July or August next it is expected to be completed. The completion of this great work has solved a problem that has occupied the attention of all interested in the city of Mexico for the past 500 years. The position of the city is unique, for no other city or town possesses such charms as does this, which is described as the most "beautiful gem of the world."



Walker & Boutall sc.

General Map of the Plains of Mexico.

The city of Mexico is built in the centre of a vast basin of an oval form, about 200 miles in circumference, and is surrounded by towering mountains, one or two being amongst the highest in the world. The soil was at one time thickly wooded, but is now mostly bare, and, in many places, white with the incrustation of salts left by the receding waters. Five lakes, occupying about one-tenth of the surface of the valley, receive the fairly heavy rainfall and the drainage of the mountains. The fall of rain and the waterspouts, which occur frequently, have been the cause of many inundations and of much destruction of life and property. These lakes have different levels, some being higher and some lower than the city, which circumstance will be readily understood as making the drainage of such a vast area a matter of great difficulty and costliness.

A brief account of the vicissitudes of this stupendous undertaking is attempted in the present paper. The archives of Mexico contain so many voluminous essays and plans of engineers—famous in their day—as well as of men of eminence in various branches of science, on this drainage scheme, that a mere mention can only be made of the principal of these in the limits of this paper; but anyone possessing a knowledge of the Spanish language would find a perusal of the documents most interesting reading.

The form of the plain of Mexico, as before stated, is oval, so that the drainage of one part, unless the scheme embraced the whole plain, could only result in flooding the other. The drainage of the entire valley was not carried out, owing to the great cost, as it was generally conceded that, however good the scheme might be, the advantages to be gained would be small. No discredit, therefore, should be considered to attach to any of the many learned men who submitted designs for effecting the drainage of the plain, as the money at command was not equal to the work suggested to be done.

Fifty years previous to the discovery of America in the year 1492, the king of the Aztecs, named Netzahualcoyotl, saw the necessity for a drainage canal, and commenced the work forty-two years previously (*i.e.* in 1450); he had constructed an immense dyke, to divide the fresh from the salt water lakes of the valley. The city of Mexico was at this time the centre of the Aztec nation, and was built on floating structures, like rafts, on the water in the numerous islets on the margins of the lakes, so that, in the event of the water rising, or the city being subjected to a state of siege, the whole city would float. Mexico city now occupies the site where once stood the grand temple of the Aztecs.

The waters of these lakes were liable to disturbances of all kinds, thus it is recorded by Prescott, in his "History of the Conquest of Mexico," page 171:—"In 1510 the great lake of Texcoco, without the occurrence of a tempest or earthquake, or any other visible cause, became violently agitated, overflowed its banks, and, pouring into the streets of Mexico, swept off many of the buildings by the fury of its waters."

When Cortes arrived in Mexico from Spain, in 1519, to take possession of the country in the name of the king of Spain, he found, to his great surprise, the defence of the city admirably arranged, and an almost enchanting view of flowering islets forming the floating capital. Little towns and villages lay half concealed by the foliage, and from the distance these looked like companies of wild swans riding quietly on the waves.

A scene so new and wonderful filled the rude heart of the Spaniard with amazement. So astonished was he at the extent of the water of Lake Texcoco, that he describes it as "a sea that embraces the whole valley;" but, upon hearing that it was a lake, with a mean depth of a few yards, he gave orders to cut a way through the dyke, and destroy the aqueduct of Chapultepec. The central dyke dividing the fresh from the salt water lake was of such dimensions as to serve Cortes as a roadway for his army.

Prescott, in the work before alluded to, page 297, says:—"Leaving the mainland, the Spaniards came on the great dyke or causeway, which stretches some four or five miles in length, and divides Lake Chalco from Xochicalco on the west. It was a lance in breadth in the narrowest part, and in some places wide enough for eight horses to ride abreast. It was a solid structnre of stone and lime, running directly through the lake, and struck the Spaniards as one of the most remarkable works they had seen in the country."

Having cut the dykes and drained the lake, the "floating city" was at once besieged, and where originally stood the great temple of the Aztecs a Christian temple was afterwards raised. The Spaniards, finding themselves in complete possession, proceeded to erect the new city of Mexico, and building on the plan adopted by them at home they cut down the points of the floating islands, and by gradual extension soon placed the town below the mean average level of the lake. Hence arose the great difficulties of the drainage of the valley of Mexico.

From 1519 to 1553 the Spaniards were busily engaged in building Mexico, and another grand dyke, similar to that built by Netzahualcoytl in 1492, was formed around the city; this protection proved insufficient, for in 1580 another inundation took place. The Viceroy of the day, Señor Don Martin Enriquez, assisted by engineers, engaged to find an outlet for the waters north of the valley. During the time they were thus engaged important facts were gleaned respecting the River Cuautitlan and its curious behaviour at the foot of Nochistongo, whence it doubled its course at a certain altitude and ran towards Lake Texcoco instead of into its own Lake of Xaltoean. The scheme formed by Enriquez to remedy this evil was kept in abeyance as his services were required in Peru.

In the year 1604 a serious inundation attacked Mexico city. The Marquis de Montesclaros did all in his power to carry out the plan of Señor Don Martin Enriquez to relieve the rivers of the north of the valley of the excess of water from the central and south lakes which are of higher altitudes. The *pros* and *cons* of this plan were beset with many great difficulties and respecting one of the methods tried, mention must be made of a dyke of great strength, constructed to prevent any excess, or overflow, of water from destroying the town of Zumpango and washing away its crops. This dyke which was to check the strong current of the River Pachuca would also direct the River Cuautitlan to Mexico, direct the rivers north into Zumpango, and would inundate that verdant district and probably submerge the town; whereas to divert them into Lake Texcoco would submerge Mexico. What was to be done? This query was answered by the decision to make a tunnel; but here, as in all countries and in all ages, engineers, when engaged in any work of magnitude, and of a different character from that commonly known, always find theorists to offer objections, and thus stop the way to actual progress. This was the case in Mexico city.

In 1607 another inundation, spreading over the whole valley, occurred, and as all the dykes and other defences were swept away, caused a panic of terror amongst the inhabitants. The Marquis de Salinas was then Governor of Mexico city, and determined to carry out the plan of Senor Don Martin Enriquez, being assisted by an engineer of great repute named Enrico Martinez, and also solicited, and obtained the co-operation of, Father Sanchez, of the Society of Jesus. These three men, after many consultations, formulated the plan of embracing the whole of the lakes of the plain into one mean channel of detention, and an outlet as required to keep the same under such control as to have at all times an abundance of water for use. The plan, broadly speaking, was to draw off the water from the south lakes which are at higher levels to those of the north, and to make them serve, by the scour the velocity of the water would cause, to deepen the passage for their exit, and, at the same time, assist the making of the grand canal.

Great opposition to this plan was offered on the score of economy, and many insisted that the inundations were solely due to the waters of Cuautitlan and the freshets of Pachuca, and if these were directed north, no more was needed; whilst the people of Zumpango tried to show that no more was needed to inundate their town and submerge the district. The Governor then requested Enrico Martinez to induce Father Sanchez to submit some modifications of his former scheme. The plan was modified, and on the 28th November, 1607 Enrico Martinez started operations on the modified plan, and in about eleven month 6,600 metres ($4\frac{1}{10}$ miles) of canal, with a transverse section of 3·50 metres ($11\frac{1}{2}$ feet) wide and a depth of 4·20 metres ($13\frac{3}{4}$ feet), was completed. At the same time, other importan drainage works were being made, the passag was opened from Boca de San Gregorio t Salto de Tula; this was 8,600 metres ($5\frac{1}{3}$ miles long, as well as two canals as aqueducts, 6 miles long, one for Lake Zumpango and th other for the River Cuautitlan from Teoloyuca to Huehuetoca.

In December, 1608, under the presidenc of Velasco and the Archbishop of Mexico Enrico Martinez inaugurated the outlet of th waters. The whole of the work just describe being executed in one year. Humbuldt tell us that 15,000 native Indians were employe on these works.

In spite of the great good these work brought to the people, there was an outcry fo economy, but it is certain that other motive prompted the disturbance and the attempt t harass and hamper the Governor. The object wa to prevent a grant of money from being mad to pay for the lining of the canal with cement. This was found to be necessary, as the greater part of the work was excavated in marl, and the liberated waters ran with such velocity, that the symmetry of the tunnel was soon destroyed, and its passage and usefulness lessened by the *débris* that obstructed the fairway. This state of things was brought so forcibly home to the objectors that a small sum of money was reluctantly granted sufficient to patch up the tunnel in places where the rush of waters had made the most havoc, hydraulic cement or mortar being used, but the sum granted was proved to be totally inadequate, and for want of more money the tunnel was rendered perfectly useless by falling obstructions. This occurred in the year 1609. Gossips and theorists then united to run down the scheme, although it was conceded that the work had averted a terrible inundation or submergence of Mexico city.

A few years elapsed before the question of continuing the works for the tunnel again caused excitement, but a general feeling grew up that the work of the tunnel should be continued. The opposition was strong enough to obtain the hearing of an appeal in Madrid, with the result that the Spanish Government, in 1614, procured the services of a Dutch engineer, named Adrian Van Boot, to proceed to Mexico city to examine and report on the canal works, and to submit a plan to remedy the evils. As the result of his labours he condemned the plan of Father Sanchez, and recommended that the old means of defence used by the Indians should again be adopted, and that dams and dykes should be thrown up at once. This report had the effect of annoying almost everybody, and was the means of much fruitless discussion. In this dilemma the Spanish Government when appealed to confessed they were unable to advise the Governor of Mexico what to do, but sent the Marquis of Gelvez to Mexico to see into matters, and he having unbounded faith in the celebrity of the Dutch engineer, Adrian Van Boot, and hoping to keep money in the treasury, ordered Enrico Martinez to close up the tunnel completely, and to return the rivers to their natural courses, but before these orders were half executed the enormous rush of waters grew so alarming that he revoked his own order and issued another to open up the tunnel and that with all speed on his personal responsibility. Although the Marquis gave these orders he forgot to give Martinez the money to carry them out, and, as a consequence, the works remained in a deplorable condition.

By order of the Marquis de Gelvez, Enrico Martinez was cast into prison for "having closed the mouth of the tunnel as a means of proving the superiority of his plan over that of Adrian Van Boot." The Marquis was soon after deposed, his place being taken by the Marquis de Ceralvo, whose first act was to set Martinez free at the request of the city council, who provided him with the means of continuing his work on the canal and tunnel.

Evaporation is so excessive at certain periods of the year, that malaria, consequent on drought, was far more dreaded by the inhabitants than the periodical floods, and thousands perished annually, so that proper drainage was an absolute necessity for the preservation of health.

On the 20th June, 1629, the ever troublesome River Cuautilla overflowed and inundated the north of the plain, and swept with it other streams into Lake Texcoco. In the September following, the increase of the water was greater than ever had been known. The city was so suddenly and completely submerged that 30,000 persons perished, the bodies floating about the streets for some time after. The destruction of property and life, consequent on the inundation, was so great generally, and effected the tunnel to such an extent, that during a period of five years there was scarcely any reduction in the height of the water, and the water in the city remained during all this time as high as the second story of the houses; the slight difference in height of the water was caused by evaporation.

The Spanish Government at Madrid gave orders to change the capital to a better and more secure site. To this suggestion the citizens demurred, saying, in effect, that to ensure complete security, an outlay of only $3,000,000 (£600,000) was necessary, this being the estimated cost of completing the tunnel, whereas to build a new city would involve an outlay of $50,000,000 (£10,000,000) with a loss of another $50,000,000 (£10,000,000) in leaving the old one.

Several plans were now submitted in opposition to that of Enrico Martinez, and one by Simon Mendez was accepted, his plan being to direct all the waters of the valley by one canal into the neck of the Tlila, the spot selected by Martinez for his outlet. It was soon discovered that the plan of Simon Mendez was far too costly, and all the money that could be spared was practically melting away without perceptable progress being made. Enrico Martinez was again requested to carry out the work as arranged with Father Sanchez.

The next Governor, the Marquis de Cadereyta, was most desirous to see the work of the tunnel pushed on; but however enthusiastic he may have been, lack of funds prevented him from giving effect to his desires. The work continued very slowly, Martinez being unable to do any work at the tunnel, and he contented himself by improving the canal by lining it in bad places with cement. Poor Martinez struggled on for 37 years with this work, and died unnoticed and uncared for. His burial place is unknown.

In 1637, an earthquake made sad havoc with the tunnel works, and for lack of funds, no repairs could take place; but when funds were obtainable, workmen could not be got, the earthquakes and inundations having carried off many thousands of these poor fellows. The survivors lacked heart to return to such an unfortunate and, as they thought, accursed work.

In the year 1640 the work was being pressed on by men from the prisons, under the direction of the Franciscan monks, and carried on, with varying results, in this way for 35 years, until Señor Martin Solis was made head of the Municipal Council. He, being an avowed enemy to the Franciscans, sent them away, and undertook the superintendence of the work himself; but his method of treating the prisoners was so harsh and cruel that they broke out into open revolt, and the works were threatened. Therefore, to save the works and his own life, he consented to the return of the Franciscans. It is estimated that up to this time some 200,000 men lost their lives on this work. The Franciscans steadily, but slowly, worked on, always with a very limited exchequer, until 1767, when there remained some 1,935 metres ($1\frac{1}{5}$ miles) still to be completed. A contract was entered into to finish this work in five years, for $800,000 (£160,000); but, instead of five years, it took 22 years, and instead of 8 metres (25 feet) wide, as contracted for, it was only 3 metres (9 ft. 10 in.) wide.

From the foregoing, it will be easily understood that the expenditure on these canal works was a great drain on the Mexican treasury. Up to the year 1637, $3,000,000 (£600,000) had been expended; between that year and 1800, $3,247,670 (£649,534) had been absorbed; and, up to 1830, the total expenditure was $8,000,000 (£1,600,000).

In 1849, Captain Smith, of the corps of American engineers, who came to Mexico with General Scott's army, adopted the plan, with slight modifications, designed by Simon Mendez. The tunnel was planned through the ravine of Acatlan, its mouth being near the village of Tequizuiac.

In 1866, a project, proposed by Señor Francisco Garray, a Mexican engineer of repute, was pronounced the most feasible, and adopted, but revolution succeeded revolution, causing the works to be stopped for some years. In 1879 Don Luis Espinosa took charge of the undertaking, and has continued to direct affairs until the present time.

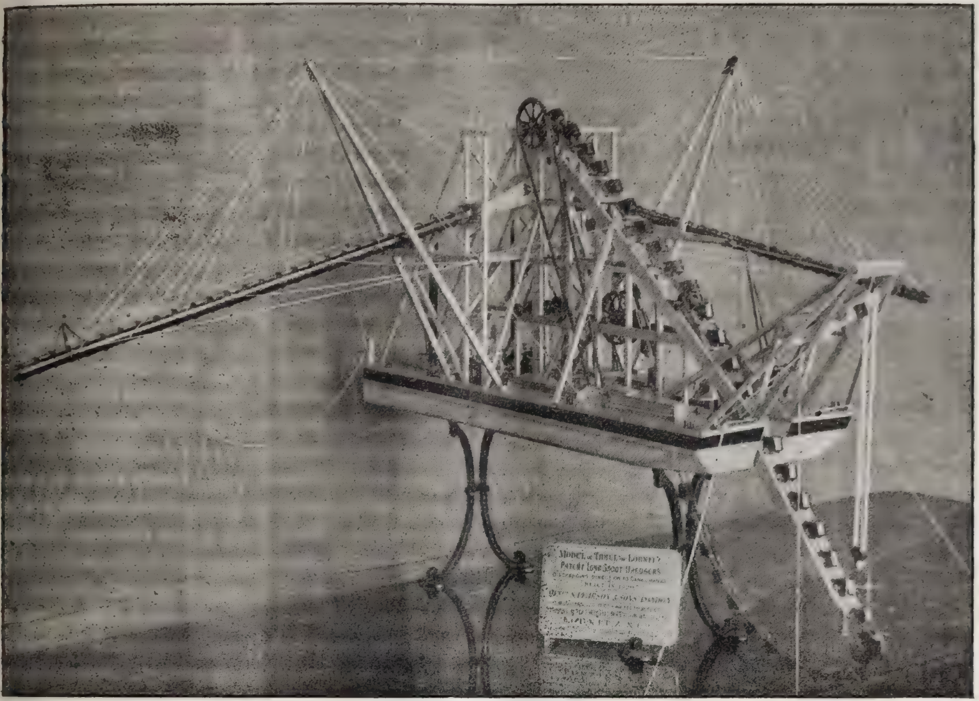
The present gigantic work cannot have been considered to have been seriously undertaken, with a view of completion, at any cost, until the year 1885, when the City Council of Mexico submitted a project to the Government, to which they offered to contribute largely in the event of its being adopted.

A special Commission, with ample authority to deal with the funds set aside for the work, was appointed by President Porforio Diaz. The City Council set aside the sum of $400,000 (£66,666) per annum for the canal works, which sum was materially increased by the Federal Government.

In 1887, the City Council raised a loan in London of £2,400,000 to meet the cost of the work and guarantee its successful termination. The entire responsibility of the work was now assumed by the City Council, and the Government gave authority for the Council to make and collect new taxes. Still, there was not sufficient money forthcoming, so another loan was raised in London for £3,000,000.

In December, 1889, the Department of Public Works contracted with Messrs. S. Pearson and Son, of London, for the completion of the canal, the excavation for which was originally contracted for by the Bueyrus Company, of the United States, of which Colonel Harris was the president. This company started with two spoon dredgers capable of raising a maximum of 1,000 cubic metres (1,308 cubic yards) a day. They commenced operations at the 22nd kilometre. This company, in the opinion of the Board of Commissioners, was not proceeding with the work at a suitable rate of speed, for, at 1,000 cubic metres (1,308 cubic yards) per day, the work of dredging alone, as there were some 16,000,000 of cubic metres (20,928,000 cubic yards) of excavation to do, would take about 43 years; their contract was therefore cancelled, and another entered into with Messrs. S. Pearson and Son as stated above, who have completed the canal to the satisfaction of all concerned in six years. Too much praise cannot be given to this firm for the way in which the work has been done by them, the best of relations existing at all times between the parties concerned representing the Federal Government and the contractors. Five large dredgers were used on the work, and by these means excavations to the depth of 20 metres ($65\frac{3}{5}$ feet) were made, and the earth was raised to an elevation of 16 metres ($52\frac{1}{2}$ feet) so as to empty it into the shoots, ultimately delivering it on to the banks on either side of the canal. These dredgers have now done their work here, three of the five having already been taken to pieces, packed, and partially transferred to the harbour works at Vera Cruz, whilst the other two were being dismantled when I visited the country in July last.

Fig. 1.

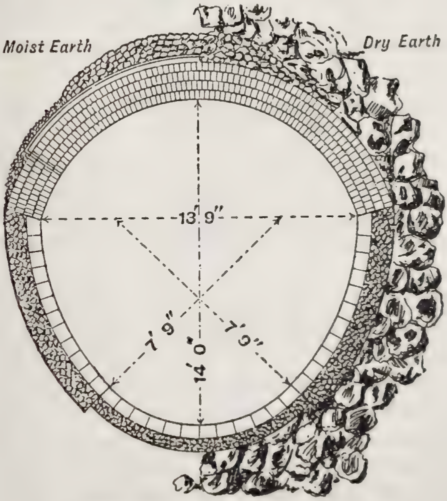


Model of Dredger Used by Messrs. Pearson.

The contract for completing the tunnel was let to Messrs. Reid and Campbell, of Mexico, but for some reason they were unable to carry out the work. It was therefore continued and satisfactorily completed by the City Council, by their own men at their own cost, for a sum considerably less than Messrs. Reid and Campbell's contract price.

The tunnel has a length of 10,021·79 metres or 32,869 feet ($6\frac{1}{5}$ miles), with a curved section formed by four curves respectively of the following dimensions (Fig. 2). The upper part has a span of 4·185 metres or 13 ft.

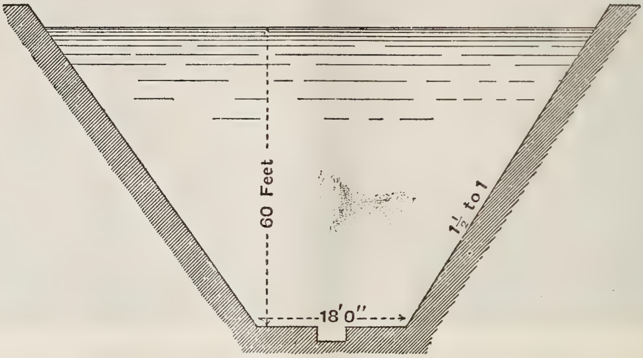
Fig. 2.



Cross Section of the Tunnel.

9 in., and a rise of 1·570 metres or 5 ft. 1½ in.; the two lateral arches have a chord each of 2·36 metres or 7 ft. 9 in., a radius with a chord of 2·429 metres or 8 feet, and a rise of 0·521 metres or 1 ft. 8½ in.; the elevation is 4·286 metres or 14 feet, and the greatest width is the span of the upper arch. The tunnel is lined with brick, having a thickness in the upper of 0·45 metres or 1 ft. 6 in., and in the lower part, over which the water runs, of 0·40 metres or 1 ft. 4 in. in the side arches, and of 0·30 metres or 1 foot in the radius, this latter lining being of artificial stone, made of sand and Portland cement. The elevation of the invert at the beginning of the tunnel is 9·20 metres or 30 ft. 1½ in. below datum; at the end of the tunnel, 17·53 metres or 57 ft. 6 in. below datum. The gradient is 0·00069 for the first 2170·74 metres, or 1 in 1449 for 7120 feet; 0·00072 for the following 5,831 metres, or 1 in 1389 for 19125 ft. 6 in.; 0·001 for 5,100 metres, or 1 in 1389 for 16728 feet, and 0·00135, 1 in 740, for the rest of the tunnel, these changes being in accordance with changes of details made from those of the original project, in some cases modifying the section and in other cases the lining. Twenty-five shafts, each 16 ft. 6¾ in. × 9 ft. 10 in., were opened at a distance of 400 metres, or 1312 feet from each other. These served to ventilate the tunnel and to facilitate the work. The deepest of these shafts, situated on the saddle of Acatlan, has a depth of 92 metres, or 301 ft. 9 in.; the shallowest is 21 metres, or 68 ft. 10 in.

FIG. 3.



CROSS SECTION OF CANAL.

To give an idea of the labour involved beyond the mere tunnelling, it is as well to mention that the quantity of materials required per lineal yard of tunnel was 1,800 bricks, 94 cement blocks, 3 cubic yards of mortar, and 70 cubic feet of volcanic stone.

Maximum discharge through the tunnel = 18 cubic metres (635⅔ cubic feet).

The canal starts from the San Lazaro station of the Hidalgo Railway, runs on the east side of the Guadelupe mountain range, between this range and Lake Texcoco. It then changes its direction to the north-west, diagonally traversing San Christobal lake, a part of Jaltocan and another of Lake Tampango, where it finishes at the mouth of the tunnel, having a total length of 67½ kilometres, or 43 miles.

The level of the bottom of the canal above the datum line adopted is 2·25 metres or 7 ft. 4 in., and the mouth of the tunnel is 9·20 metres, or 30 ft. ½ in. below the same datum, supposed to pass 10 metres, or 32·80 feet below the bottom of the Aztec Calender Stone. The level of the ground at the beginning of the canal is 8·94 metres, or 29 ft. 4 in., and at the end 15·86 metres, or 52 feet above datum The uniform slope of the canal is at the rate o 0·187 per kilometre.

The canal has a depth, at its commencement of 5·50 metres, or 18 feet, which, in the last few kilometres, is increased to 20·50 metres, o 67 ft. 3 in.

The side slopes are projected with a batte of 45 degrees, and the width of the bottom is 5·50 metres, or 18 feet, for the first 20 kilo metres, or 12½ miles, and 6·50 metres, or 21 ft 4 in., in the rest of the canal.

Referring to the map, the first 20 kilometres or 12½ miles, may be considered as a pro longation of the net of sewers in the city, and will receive only the water that passes through them.

The flow is calculated for an average of 5 cubic

FIG. 4.—LONGITUDINAL SECTION OF THE CANAL.

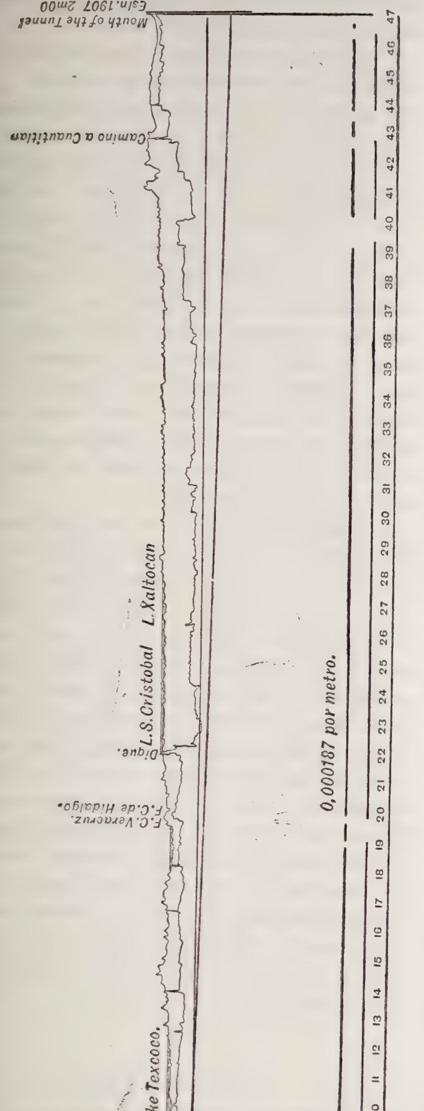
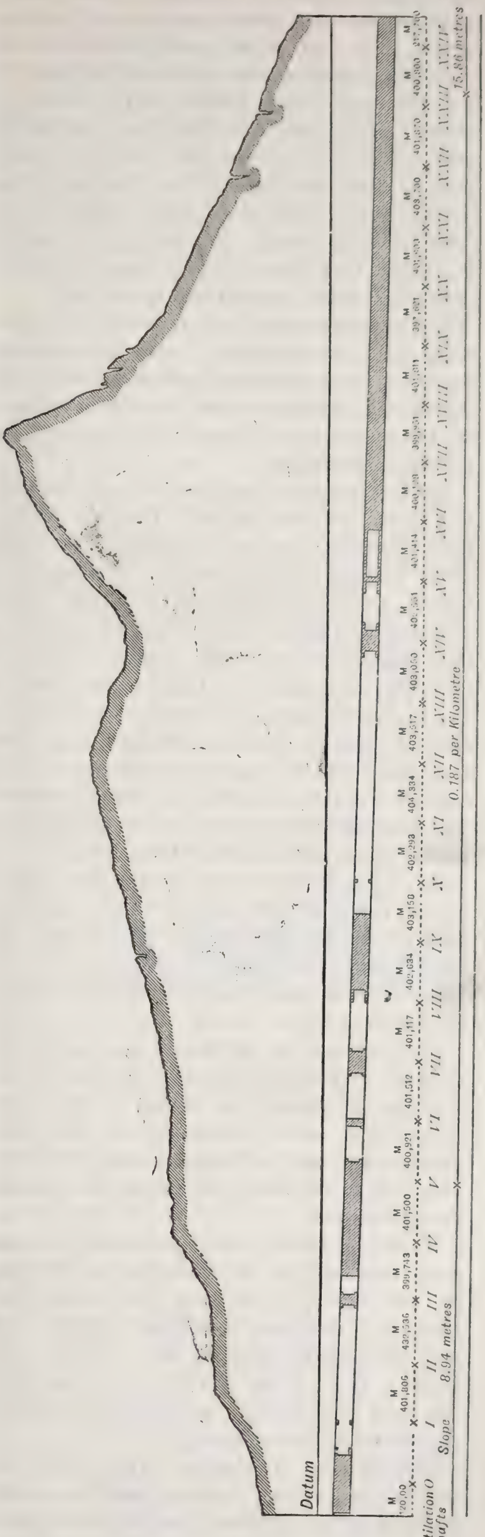


FIG. 5.—LONGITUDINAL SECTION OF THE TUNNEL.



metres (176½ cubic feet), although, when heavy rains require it, a greater volume can be received. The rest of the canal communicates with Lake Texcoco, and is utilised in controlling its waters—the lowest in the valley—which can be made to flow into the canal from all parts. Hence the canal has been built to carry the largest flow that can pass through the tunnel, or 18 cubic metres (635⅗ cubic feet) per second. The cutting is through a strictly clay formation, composing occasional thin strata of sand and sandstone.

For accommodation of railroads, waggon roads, and watercourses, it was necessary to construct five aqueducts—four of masonry and one of iron—to carry rivers; four iron bridges for the passage of railroads; and 14 bridges for vehicular traffic.

For a century the problem has been settling into one of pure sanitation. The plans which the Government has been working since about 1883, though called plans for draining the valley, are really intended to obtain a fall sufficient to dispose of the sewage; in fact, in the original plan, from considerations of economy, care was to be taken to keep out of the projected canal all water, both from the surface of the valley and from the rivers. The Consulado and Guadalupe rivers were to be carried over the new canal in iron aqueducts. The drainage system was thus to be simply a part of the sewage system of the city.

Sluice gates direct the city drainage either to the canal or to Lake Texcoco. A sluice gate at the junction of the smaller with the larger part of the canal controls the flow of Lake Texcoco, and another sluice is placed at the entrance of the tunnel.

The total cost of the tunnel and canal may be taken as being $56,000,000 (£7,000,000).

When I visited the works in July last, there were some hundreds of men preparing what may be termed a sluice chamber, which is to regulate the supply of drainage into the tunnel.

It will be readily understood that the great good that will accrue from this canal cannot be thoroughly appreciated for some time. When the drainage is effected, Mexico city, with its sublime climate, must be the most healthy city in the world, as it was lately the most pestilential one, having the highest death-rate of any other city.

The climate of Mexico city is justly described as "eternal spring," and the advantages to be derived from this fact alone cannot be over-estimated. It stands 7,000 feet above the sea level, and in July has a temperature of about 72° Fahr. at noon. With safe building ground, Mexico should be a city of millions of inhabitants instead of about 500,000, its population at the present day.

Geologically considered, the plain of Mexico belongs to the primitive system of rocks: granite, gneiss, basalt, and the later traps resulting in an infinite variety of mineral compounds capable of producing all kinds of vegetation in abundance. There is, in fact, one season for fruits and flowers, lasting the whole year.

Nothing short of an open-handed, generous Nature could have produced such prodigious richness of soil and abundance of harvest, and these elements induced the people to remain in spite of great risks of nearly every kind—political, social, and natural; to say nothing of inundations, civil wars, earthquakes, partial or total destruction of their country in the plains, as well as their great and glorious city of Mexico.

In conclusion, the author begs to thank the President of the Republic, who has at all times, in spite of the immense amount of work he has to get through daily, received him with the utmost kindness and courtesy, and readily placed at his disposal the most valuable data on on the subject of the canal. His thanks are also due to Señor Don Manuel Cosio, late Minister of Public Works, and Señor Don L. Salazar, the Secretary to the Minister, for the valuable information they so readily placed at his disposal to enable him to prepare this paper.

The name of General Porforio Diaz, the President of the Republic, will always glorify an important page in the history of his country on account of his Excellency's intimate connection with one of the greatest engineering achievements of the century.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said it ought to be a matter of some little pride that this work which had been about 500 years in progress, had at last been successfully completed by an English firm. He observed in the paper a fact which it might be well to note, viz., that the City Council of Mexico, on the contractors failing to carry out their contract, finished the work themselves at considerably less cost than the original estimate. Not being an engineer, he did not feel competent to offer any comments on the paper but he hoped some further information might be elicited.

Mr. COTTRELL said he had jotted down some particulars about a similar work, which he believed was the only one in the world bearing any analogy to the one now described. He referred to the drainage of Lake Fucino, in Italy, which was undertaken for very much the same reasons, and was first taken in hand by the Romans under the Emperor Claudius. The area of the basin was 173,000 acres; of the lake 37,050 acres. There was no constant outflow, and the lake was subject to sudden risings. The water level was 2,100 feet above sea level, and villages and cultivated land were subject to recurring damage from floods, and the inhabitants to serious mortality from malarious emanations from stagnant waters and evaporations from the rich soil. The depth of the lake in the time of Claudius was 53¾ feet, but the bottom had been raised since by 15⅔ feet. The work was undertaken by contract under Claudius, A.D. 44 to 54, 30,000 men being engaged. The tunnel had a cross section of 11·9 square yards; the average gradient was 1½ per 1,000; length, 6,178½ yards; intake, 30 feet above lake bottom. There were 40 shafts, from 57¾ feet to 400 feet in depth, sunk 19 feet by 13 feet. The work was, however, scamped, and the softer portions, which were not lined, gave way, and the tunnel was more or less blocked down to modern times, and completely so from 1783, since which date the level of the lake steadily rose till it was drained. The Emperors Trajan and Hadrian tried to repair the work, and in the Middle Ages, Frederick II. and Alphonso I. did the same; but it was left to private enterprise and our own day to achieve success. A concession of all the land reclaimed by drainage was given to Prince Torlonia, and work was commenced on plans drawn up by a Swiss engineer, De Montricher, in 1852. The particulars of this work, which was successfully completed, were as follows:—Length of tunnel, 6,887 yards (through 2,813 yards hard rock, 344 yards soft, 3,728 yards clay, &c.); cross section 19 feet by 13 feet, or 216 square feet; slope, 1 in 1,000; maximum flow of water 11,000 gallons per second; depth, 17½ feet above invert outlet, 11 miles from lake, and 2⅔ feet below Roman outlet. The Roman tunnel was utilised as a heading. The accessory works included 28 shafts of a total length of 1,500 yards (12 of which were over 279 feet deep) and two inclined galleries, 568 yards. The canal from the lake was 49·21 feet wide, and 8¼ miles in length. Besides this there were 30 miles of roads, 62 miles of subsidiary canals and drains, and 402¼ miles of ditches. The cost was £1,000,000 for tunnel and drainage, £600,000 for easements and compensation, £200,000 for interest and preliminary expenses, making a total of £1,800,000. The result achieved was 35,012 acres perfectly drained and brought under cultivation, and an immediate enhanced value of the surrounding property by £160,000. This work was comparable with the Mexican canal in many ways, especially in having been started and partly achieved by the Romans as far back as the first ifty years of our era, while it was only completed by private enterprise in the fifties.

Mr. **Praed** asked if the canal was used at all for traffic?

Mr. **Cheesewright** said the Hidalgo railway ran along the banks towards the mining district of Pachuca, but he did not think the canal itself could ever be utilised. For one reason it absolutely swarmed with mosquitoes, much worse than he had met with in Burmah, Rangoon, or in Australia; the canal was absolutely black with them, so that navigation would have to be carried on in diving dress if at all. In reply to further questions, he said the water supply of Mexico was derived from the mountains; there was no difficulty about that; the only difficulty was to get rid of it. The Aztec Calendar Stone was now in the Museum in Mexico; it formerly stood under the dome of the Aztec temple, the site of which was now occupied by the cathedral. The stone was the most wonderful piece of carving he had ever seen. When Cortes went there, he found the Aztecs worshipped at the sign of the cross, and to the present day were still to be seen, a little to the south, the ruins of perfect architecture, similar to what is found in Egypt. The gods worshipped by the Aztecs were the same as those of the Assyrians, the snake and the toad, and huge images of these animals, beautifully carved in granite, were preserved in the Museum. The Calendar Stone would form the substance of a lecture by itself. It was about 12 feet in diameter, and was covered with hieroglyphics. Oaxaca, another large Aztec city, remained almost intact to the present day. He thought it was quite certain that the Spaniards were not the first Easterns to visit Mexico.

Mr. **Praed** asked, what were the probabilities of the Mexican loan? The interest upon it must be a very heavy charge; and some years ago the interest was not paid, though certainly of late years it had been.

Mr. **Cheesewright** said the Mexicans had never repudiated any loan they raised, however dearly they might have had to pay for the money. The State of Mexico paid about one-third of the interest on these bonds, and the rest of the country paid the other two-thirds. They were now busying themselves with plans for the proper drainage of the city, which would cost 1,500,000 to 2,000,000 sterling. The products of the plains of Mexico were sugar and fruits, it was too high for coffee, but all English fruits grew luxuriantly. The natives did very little work, a small plot of ground, which was easily obtainable, being enough to afford subsistence for a family. If they did anything else it was a little matmaking or weaving calico, in order to by tools with the proceeds of the sale. The most marvellous sights there were the floating islands, varying in size from 20 feet in diameter to some miles, with trees and houses upon them. These were seen on the borders of the city and were very beautiful.

The CHAIRMAN then proposed a vote of thanks to Mr. Cheesewright. The paper was exceedingly interesting, both from the historic and from the engineering point of view, and the little side lights which had been thrown on life in Mexico, if not altogether charming, were full of interest. He hoped the canal would do something to get rid of the mosquitoes; and if Mr. Cheesewright had discovered any method of evading their attacks, he would be conferring a public benefit by making it known.

The vote of thanks having been carried unanimously,

Mr. CHEESEWRIGHT, in reply, said it had given him great pleasure to read the paper. Its inception was due to the President of the Republic, who did not think sufficient justice was done to Mexico on this side. He therefore directed the Minister of Public Works to take him over the canal, and then supplied him with at least half a hundredweight of readable matter, giving the whole history of the works for the last 500 years. He waded through it, and though it was difficult to give much of the result in an hour's paper, he was quite satisfied if he had succeeded in making the subject at all interesting.

Miscellaneous.

CHICAGO EXHIBITION MEDALS.

The following extract from the *New York Tribune*, of January 25th, gives the latest information as to the arrangements for the distribution of the Chicago Exhibition medals :—

"It would seem that the vicissitudes of the World's Fair awards are never to end. After a long controversy, the point of making both medals and diplomas was finally reached. The contract for the medals was let to a firm in Waterbury, Conn.; that for the diplomas to the Bureau of Engraving and Printing, under the Government. Then everything went on smoothly, or seemed to. But there was a hitch. Congress, however, consigned the whole matter to the Secretary of the Treasury. Now there is another hitch, and the Treasury people are at a standstill, though neither medals nor diplomas are yet ready for distribution. They are nearly completed, but the present Controller's interpretation of the Act of Congress now takes the business from the Secretary of the Treasury and puts it on the World's Columbian Commission, of which ex-Senator Palmer, of Michigan, is the president.

"The Waterbury firm, it is said, has done good work on the medal, but lost money by it. It has been extremely difficult to get the names of exhibitors in the small space of the die on the medal, which, from the first was regarded as a serious drawback to the design substituted for that of Mr. St. Gaudens. But as the designer had spent above a year trying to make a design which would meet the artistic and moral views of the Committee of Congress, it was thought best not to cause further delay by any more tinkering with the medal.

"With the small space for names, the Waterbury firm has had a daily struggle, the names of foreign exhibitors especially, even when crowded in very small type, being twice too long for the die. As a consequence, many foreign names have been abbreviated or cut in two in the middle, the exhibitor having the choice as to which end of his name he would prefer on his medal.

"One hitch in the diploma was paper. Instead of using American parchment, Japanese rice paper was used, which, of course, had to be sent for and brought from Japan.

"Nobody knows when the awards will be sent to exhibitors, but it is known that President Palmer declares that he will never call the Commission together until he has absolute proofs that the awards are ready for distribution."

BRUSSELS EXHIBITION, 1897.

Information has been received from the Foreign Office, through the Science and Art Department, respecting the International Exhibition to be held in Brussels in 1897. The King has chosen a Commission for the purpose of organising the Exhibition, and has appointed H.R.H. the Comte de Flandre as Honorary President of the Commission. H.R.H. the Comtesse de Flandre is named Honorary President of the Section devoted to the Practical Instruction of Women, and H.R.H. the Princess Clementine as Honorary President of the Section of Industrial and Decorative Arts. The Exhibition will be arranged under the following Sections :—

I. Fine Arts.
II. Social Economy.
III. Hygiene.
IV. Live-saving Apparatus.
V. Industrial and Decorative Art.
VI. Lighting and Heating.
VII. Electricity—Traction.
VIII. Military Art.
IX. Manufactures, Materials, Processes, and Products.
X. Sports.
XI. Popular Games.
XII. Agriculture and Horticulture.
XIII. Practical Instruction and Work of Women.
XIV. Commerce, Colonies.

SANITARY INSTITUTE.

The Twenty-First Course of Lectures and Demonstrations for Sanitary Officers will be delivered on Mondays and Thursdays, at 8 p.m.:—

Feb. 17, Introductory Lecture, by Prof. A. Wynter Blyth. Feb. 20, "Sanitary Law: English, Scotch, nd Irish," by Herbert Manley, M.A. Feb. 24, "The Law Relating to the Supervision of Food Supply," by Prof. A. Wynter Blyth. Feb. 27, "Sanitary Laws and Regulations Governing the Metropolis," by Prof. A. Wynter Blyth.

Mar. 2, "Nature of Nuisances, including Nuisances he Abatement of which is Difficult," by Arthur Newsholme, M.D. Mar. 5, "Objects and Methods f Inspection," by J. F. J. Sykes, D.Sc., M.D. Mar. 9, "Trade Nuisances," by Prof. A. Bostock Hill, M.D. Mar. 12, "Water Supply, Drinking Water, Pollution of Water," by Prof. W. H. Cor-eld, M.A., M.D. Mar. 16, "Infectious Diseases nd Methods of Disinfection," by Joseph Priestley, B.A., M.D. Mar. 19, "Diseases of Animals in Relation to Meat Supply; Characteristics of Vege-ables, Fish, &c., unfit for Food," by Alfred Hill, M.D. Mar. 23, "Ventilation, Warming, and Light-ig," by Louis Parkes, M.D. Mar. 26, "Principles f Calculating Areas, Cubic Spaces, &c.; Interpre-tion of Plans and Sections to Scale," by J. Wallace eggs. Mar. 30, "Sanitary Building Construction," y T. Roger Smith, F.R.I.B.A.

Apr. 9, "Details of Plumbers' Work," by J. Wright Clarke. Apr. 13, "Sanitary Appliances," y George Reid, M.D. Apr. 16, "House Drain-ge," by W. C. Tyndale, Assoc.M.Inst.C.E. pr. 20, "Sewerage and Sewage Disposal," by rof. Henry Robinson, M.Inst.C.E. Apr. 23, Scavenging: Disposal of House Refuse," by harles Mason.

FRUIT PRESERVING IN THE CRIMEA.

Fruit preserving is quite a new industry in the imea, but the British Vice-Consul at Sebastopol ates in his last report, that in the very short time it s existed it has developed so rapidly that it seems obable that it will not only do away entirely with the ported article, but even become an article of port. With the exception of oranges and lemons, e Crimea produces every sort of fruit required, and capable of producing any quantity for which there y be a demand. As early as 1840 attempts were de by the Government to introduce this industry, t until the railway was opened in 1874 connecting Crimea with the rest of Russia, the cost of nsport prevented fruit preserved in the Crimea m competing favourably with that imported, while was out of the question to export fresh fruit for ing, so that fruit cultivation was little thought of. soon as the railway was completed Moscow rchants bought up large quantities of fruit, which they sent to Moscow partly for eating and partly for preserving, but the difficulty of sending some of the more perishable sorts of fruit led them to try preserving on the spot, and the result was such a success that hardly any fruit except that for consumption as such, is now sent away. The first trial was made in 1877 at Simferopol by the Russian firm, Abricosoff Sons. For thrre years the fruit was preserved by them without special machinery, but in 1880 the business had grown so much that the firm sent to France for a skilled manager, by whose advice steam apparatus for boiling, drying, &c., was erected. In 1879 another well-known Moscow firm set up a factory at Simferopol, also under foreign superintendence, and in 1884 Constantinoff set up a factory more especially for the so-called "Puré of Tomatoes," which has now become a Crimean speciality. Since then several smaller factories have been started at Kertch, Simferopol, and other places, which every year increase their output. At first the price of fruit was very low, but it soon rose, and although large gardens and orchards are continually being laid out, the demand increases as fast as the supply, so that the price is maintained, and there are gardens where £200 to £250 is paid for the apricot crop alone. The fruit is sold on the trees before it ripens as soon as the amount can be estimated, so that the purchasers take all risks. Competition is not felt by the factories, as the demand is equal to the supply, and both grow continually. The factories turn out bottled and tinned fruits, fruits in syrup, crystallised fruits (glacé), jams, jellies, and puré, which is a sort of stewed fruit; the fruits used being apricots, peaches, pears, apples, quinces, figs, plums, cherries, sweet and water melons, walnuts, tomatoes, oranges, and lemons; the oranges and lemons being the only imported fruit, all the rest being grown in the Crimea. The quantities of fruit bought up by the three principal factories alone, in 1894 amounted to 1,600 tons, valued at £14,100. Each year about 10,000 tons of fresh fruit, valued at £140,000, are sent tothe north of Russia for eating. From the above it will be seen that the cultivation of fruit has now attained very large proportions in the Crimea, and particularly noticeable is the quantity of tomatoes taken up by the factories in 1894 (1,000 tons). Until the factories were started the tomato was very little grown, as it would not bear transport, and the local demand was small, but now it is largely cultivated as a most profitable crop. The produce of the factories, especially the crystallised fruits, compare very favourably with those prepared in France. In 1895 the fruit harvest was almost a total failure, so that large quantities had to be imported from Bessarabia.

PRODUCTION OF SUMAC IN PALERMO.

The British Consul at Palermo, in his report on the trade and commerce of this consular district for

1894, embodies some very valuable remarks on two important industries, namely, that of sumac and of oranges and lemons. As little is generally known about these, and as many inquiries seem recently to have been made in Palermo, the following abstract will assist in disseminating the knowledge beyond the circle reached by the report itself.

Sumac, or as it is sometimes spelt, Shumac, is a commercial name for a tanning substance, furnished by the leaves and twigs of several species of *Rhus*, growing in Southern Europe and in America. The plant which produces Sicilian sumac is *Rhus coriaria*, while *R. Cotinus* gives Venetian sumac. It is, therefore, the former plant that is referred to in the report. It is described as a hardy shrub, which grows upon available patches of ground on the hillsides and the slopes of the mountains. It does not require a good soil, but, on the contrary, is generally found flourishing in the most stony and poor ground. The plant attains a height of about 1½ ft. The harvest takes place during the months of July, August, and September. This species of sumac is locally known as "strong" (owing to the greater per-centage of tannin which it yields), in contradistinction to the similar plant known as "Sommacco femminello," called also Catania sumac, although, in point or fact, it is not limited to the province of Catania, but, on the contrary, is very common throughout the whole of the province of Palermo.

The leaves of the latter (femminello) are smaller, and of much less strength, than those of the former plant, which is known as "sommacco forte," or "mascolino." They are, therefore, of less value, and are consequently largely used in the adulteration of ground sumac. Two other plants, which are said to closely resemble each other, and are named respectively, "binca" and "stinco," are largely used in the sumac trade to adulterate the genuine article. They are small trees, and have no leaf properly speaking, but, in place of leaves, they have prickly little shoots, which thickly cover the lesser branches, and which, after being collected, are ground up and mixed with the product of the true sumac plant. What the plants here referred to really are does not appear, but it is well known that in Tuscany sumac is often adulterated with the leaflets of *Pistacia lentiscus*, and many other plants are no doubt often used. These very inferior qualities often contain a large proportion of earth, owing to the impossibility of making them undergo a process called ventilation, to which pure sumac is invariably submitted, and is then freed from much of the impurity in the shape of the native soil, which finds its way into the mills together with the leaf, having been taken up during harvesting. Of late years, there has been a continuous falling off in the quantity of sumac exported, both as regards "leaf" and "ground," the demand being much slacker than formerly. This falling off in the demand may be a natural sequence of the ever-increasing adulterati
in the article, which is now carried on to a gre
extent, and made a fine art of. What formerly we
forward under the name of sumac was really t
product of the plant itself, with a very small additi
of undefined vegetable matter. What is now sold
sumac is a mysterious vegetable compound, with
infinitesimal quantity of sumac added thereto.

Whether the adulteration which now goes on
the result of the increasing competition all roun
and an attempt to sell at anything near the pri
offered, or whether it is due to the class of deal
into whose hands the sumac trade has now fallen,
a question which will admit of a great deal of arg
ment. In 1894, the quantity of sumac ground a
in leaf exported from Palermo to the United Ki
dom amounted, in round numbers, to 3,400 to
and the approximate value of the same, to £26,1
while the total export of sumac to all countr
during the same period was about 25,000 tons,
which France alone took some 10,000 tons, mostly
leaf, and America 5,500 tons, Germany coming n
with 3,265 tons, or very nearly as much as was ta
by Great Britain. The approximate value of all
sumac exported from Palermo to all countries dur
1894 was £192,923. The price of sumac is gener
at its lowest during and immediately after harvesti
when, very naturally, the peasant proprietors
anxious to realise, not being able to defer handl
their money and wait for a rise, which is very nea
certain to take place later in the season. It is at t
period that the speculator steps in and buys up
that his means will allow, to be stored and locked
till the anticipated rise takes place. Very freque
the price reached is not sufficiently tempting
induce the holder to part with his stock, in wh
case the stock will remain on hand till next sea
and come on the market together with the new c
The buying and selling of sumac and its kin
plants is wholly conducted on the basis of
obsolete weight and moneys of Sicily. Altho
all the transactions in sumac are calculated on
basis of these ancient weights and coins, yet no s
moneys are in actual circulation; consequently, e
calculation has to be reduced again to the deci
system, the currency in Palermo, as elsewhere in
kingdom of Italy, being lire and centesimi.
value of sumac varies considerably, according to
demand and the season.

After the sumac leaf has been subjected to
first process of trituration, there remains a cer
amount of coarse stuff; this is ground over ag
and the product is added to what has been alre
obtained. Still there is left a certain residuu
unground leaves, stalks, &c., and this residuu
technically known, in Sicilian, as "peduzzo."
name given to the small stalks branching from
main root of the sumac plant, and to which le
are directly attached, is "gambuzzo." These
receive a degree of grinding, and the result is a
to the aforesaid "peduzzo" before the latter

been reground, but not before it has been sifted, and the coarser ungrindable part set aside to be utilised in its turn as additional and auxiliary fuel in the furnaces. Referring to the per-centage of tannin contained in sumac, it is stated that the absolutely pure article "should contain from 30 to 32 per cent. of tannin, expressed as oxalic acid, or 20 to 22 per cent. tannin as gallo-tannic acid." Pure "femminello," on the other hand, would only contain from 20 to 26 per cent. of tannin (oxalic acid) and 16 to 18 per cent. tannin, expressed as gallo-tannic acid. However, perfect purity in sumac is only a chemical expression, it never appears on the market. A satisfactory quality, and one of greater strength than is usually sold, would be two-thirds of genuine strong sumac, and one-third femminello, and this should give an average of about 29 per cent. gallo-tannic acid (when properly ground and mixed).

Notes on Books.

EXERCISE BOOK OF ELEMENTARY PRACTICAL PHYSICS. By R. A. Gregory. London: Macmillan. 1895.

These exercises are arranged on the same plan as the syllabus for a course of lessons in elementary physics prepared by Professor Grylls Adams for the Association of Headmasters. They commence with exercises on measurements of lengths and areas, and include simple examples of such subjects as specific geometry, pressure, pumps, the mechanical powers, temperature, solution, and dioxidation. They are all of a thoroughly elementary character, suitable for first year students in science schools. It must be admitted that in some cases a desire for simplicity has overcome scientific accuracy. Thus the area of a circle is obviously not the same as the area of the rectangle, which may be made up of the triangles into which a polygon inscribed in the circle can be divided, but no suggestion is made that the solution is only approximate. The book is finished so as to afford space for the working out of the exercises, and in the hands of a judicious teacher should be serviceable.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 12.—"Water Purification by means of Iron." By F. A. ANDERSON. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

FEBRUARY 19.—"Report of the Royal Commission on Secondary Education." By H. MACAN. SIR OWEN ROBERTS, M.A., will preside.

FEBRUARY 26.—"The Standard of Musical Pitch." By A. J. HIPKINS. SIR ALEXANDER C. MACKENZIE, Mus.Doc., will preside.

Papers for evenings, the dates of which are not yet fixed:—

"Dairy Produce." By GEORGE BARHAM.

"Peasant Life and Industries in Ireland." By PROF. HADDON.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Early English Organ Writers." By BURNHAM HORNER.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

FEBRUARY 13, at 4.30.—"Punjab Irrigation—Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab. LIEUT.-GENERAL R. STRACHEY, R.E., C.S.I., F.R.S., will preside.

FEBRUARY 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. TRIPP, formerly of Sumatra. THE MARQUIS OF LORNE, K.T., M.P., will preside.

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S. WALTER CRANE, R.I., will preside.

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

FEBRUARY 18.—"Recent Developments in Electrical Enterprise in America." By G. F. PARSHALL (General Electric Company, U.S.A.). W. H. PREECE, C.B., F.R.S., Vice-President of the Society, will preside.

MARCH 3.—"The Commercial Prospects of English East Africa, and British Central Africa." By G. SCOTT ELLIOT. SIR JAMES CRICHTON BROWNE will preside.

MARCH 17.—"The Maories." By H. VOGEL. SIR WESTBY PERCEVAL, K.C.M.G., Member of the Council, will preside.

APRIL 21.—"Madagascar." By CAPTAIN PASFIELD OLIVER. MAJOR MARINDIN, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.

FEBRUARY 10.—LECTURE IV.—*The Employment of the Transformer.*—Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs or alternating current stations—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 10 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. A. Fleming, "Alternate Current Transformers." (Lecture IV.)

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. G. L. Addenbrook, "Applications of Electrical Energy."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Dr. Dawson Turner, "The New Method of Photography by Cathodic Rays." (With Illustrations and Experiments.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. F. W. Howell, "The Giant Glaciers of Central Iceland."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Professor John Milne, "Movements of the Earth's Crust, with Experiments and Illustrations."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. D'Arcy Power, "Meals of our Ancestors."

TUESDAY FEB. 11...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Coverings of Plants and Animals: its Structure and Functions." (Lecture V.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. 1. Annual General Meeting. 2. Mr. A. A. Campbell Swinton, "The New Shadow Photography."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Lt.-Col. Sir George S. Clarke, "National Defence."

Asiatic, 22, Albemarle-street, W., 3 p.m.

WEDNESDAY, FEB. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. A. Anderson, "Water Purification by Means of Iron."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Dr. S. M. Copeman, "The Influence of Subsoil Water on Health."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Major A. G. Rickards, "The Volunteer of To-day—his Military Status, his Duties, and his Training."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. 1. Mr. J. Cole, "A New Flexible Front Camera." 2. Exhibition of Lantern Slides.

THURSDAY, FEB. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir James Broadwood Lyall, "Punjab Irrigation: Ancient and Modern."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. H. F. Heath, "The Stage from Shakspeare to Irving."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. Marshall Ward, "Some Aspects of Modern Botany." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. Bathurst's Paper, "The Electric Wiring Question." 2. Discussion on Mr. Samuel Mavor's Paper, "Concrete Wiring."

Civil and Mechanical Engineers, 45, Charing-cross, S.W., 7 p.m. Mr. W. Cooper Penn, "Anchors."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. A. Campbell Swinton, "The New Photography."

Imperial Institute, South Kensington, S.W., 5 p.m. Prof. R. Beaumont, "Design in Woven Fabrics."

FRIDAY, FEB. 14... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. J. J. Armistead, "Fish Culture."

Astronomical, Burlington-house, W., 3 p.m. Annual Meeting.

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. F. J. Bancroft, "The Stability of Tall Chimneys."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W., 5 p.m. 1. Annual General Meeting. 2. Messrs. Ramsay and Eumorfopoulos, "The Determination of High Temperatures with the Meldometer."

SATURDAY, FEB. 15 ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. H Parry, "Realism and Idealism in Musical Art." (Lecture III.)

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FRIDAY, FEBRUARY 14, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Dr. J. A. Fleming, F.R.S., delivered the fourth and last lecture of his course on "Alternate Current Transformers," on Monday evening, 10th inst.

On the motion of the Chairman, a cordial vote of thanks was passed to the lecturer for his instructive course.

The lectures will be published in the *Journal* during the summer recess.

Proceedings of the Society.

TENTH ORDINARY MEETING.

Wednesday, February 12, 1896; Sir Douglas Galton, K.C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Baker, Edward, 10, Philbeach-gardens, South Kensington, S.W.
Harris, Harry, care of The Straits Trading Company, Singapore.
Holmes, Henry, 20, St. Lawrence-road, North Kensington, W.
ones, Robert H., Ardenham, The Grange, Gunnersbury, W.
eynolds, Edward P., Clovelly Tower, Ranmoor, Sheffield.
Varden-Stevens, Frederick Joseph, Martin's-chambers, Cannon-street, E.C.

The following candidates were balloted for, nd duly elected members of the Society:—

nerjee, Gopal Chandra, Cawnpore, N.W.P., India.
ddulph, C. E., Secunderabad, India.
artley, Harold, 63, New-park-road, Streatham-hill, S.W.
awthorn, James G., 41, East India Dock-road, E.
Scott, James George, C.I.E., care of R. F. Scott, St. John's College, Cambridge.
Terry, Stephen Harding, 17, Victoria-street, S.W.

The paper read was—

THE PURIFICATION OF WATER BY MEANS OF METALLIC IRON.

By F. A. Anderson, B.Sc., F.I.C.

It is now nearly ten years ago since my Father read a paper in this room upon the subject which I am treating this evening. At that time the process for the purification of water upon the large scale, by means of agitation with metallic iron, had been applied at only one or two waterworks, and the information given as to its efficacy, though quite conclusive, was necessarily rather limited. Since that time a considerable mass of evidence has been accumulated, not only from Antwerp, the original birthplace of the process, but also from a number of other important places which have followed Antwerp's example. My object this evening is to briefly describe some of the new plants that have been erected, and to lay before you a few of the results obtained.

In my Father's paper already referred to, the process was fully described, and no very material change has taken place since in the apparatus or method of working. I think, nevertheless, that it will be desirable to again briefly describe the method, and to mention one or two improvements [which have been added.

The idea of purifying water by agitating it with metallic iron was due to Sir Frederick Abel, and, as you are probably aware, arose from the difficulty experienced by the Waterworks Company of Antwerp, where spongy iron filter beds were at first employed. These beds, after working well for three years, finally became choked, and it was necessary to at once replace them by some other arrangement. Sir Frederick Abel's idea of agitating the water with scrap iron and filtering through sand after was worked out into practical shape by my Father after many experiments.

The revolving purifier is a cylindrical vessel, either of cast iron, or built up of plates like a boiler, supported horizontally upon hollow trunnions, through one of which the water to be purified enters; after traversing the cylinder, it leaves by the other trunnion. The cylinder is caused to rotate about its axis by means of a gearing, which is driven in any convenient way.

Fixed inside the shell of the cylinder, and running longitudinally, are six shelves, five of which are curved in the direction of motion of the cylinder. The sixth shelf is not curved, but is formed of a number of square flat plates, each of which is fixed to a bolt which passes through a hole in the shell of the cylinder, and is secured by a nut on the outside. This permits each plate to be set at an angle with the axis of the cylinder. In large machines, the shelves do not run direct from one end of the cylinder to the other, but are divided into a number of different sections, each of which is placed slightly behind the one preceding it. This echelon arrangement ensures a more continuous and regular action of the apparatus.

The cylinder is provided with a man-hole, and a cock for the escape of air when being filled with water. It is charged with a certain quantity of metallic iron, according to size, a purifier capable of treating a million gallons of water in twenty-four hours requiring a charge of two tons or more. The iron may be in any convenient form, but that most commonly employed in practice is the burrs or punchings from plates. Cast-iron borings are very efficient, and, weight for weight, much cheaper, but the waste due to the breaking up of the borings into small fragments, which are carried out of the cylinder with the water, counterbalances this advantage. The charge of iron, in whatever form, is spread evenly along the bottom of the cylinder before commencing to work.

In starting the apparatus, the cylinder is set with the air-cock at the highest point. The air-cock is opened, and the water admitted by opening the valve on the inlet pipe. When all the air has been expelled, and the cylinder is full of water, the air-cock is closed, and the machine set in motion.

The water on first entering the cylinder strikes against a circular baffle plate, which directs the stream towards the shell, and prevents it from passing through axially. As the cylinder rotates, the curved shelves scoop up the charge of iron, and shower it down through the water as they reach the top, thus causing a constant falling of the iron across the current of the water.

The plates which form the sixth shelf are set at an angle with the axis of the machine, and direct the iron which they scoop up towards the inlet end of the purifier, thus counteracting any tendency for the general mass of the charge to be carried by the current towards the outlet end.

The outlet pipe terminates inside the cylinder in an inverted bell or hood, coming as low down as the shelves will permit. The object of this contrivance is to prevent any iron from being carried out of the cylinder by the current.

The revolving purifiers are made in fourteen sizes, distinguished by the diameter of their inlet pipes, from 1 inch to 14 inch. In large installations batteries of purifiers are employed placed side by side, very frequently all discharging into a common outlet tank.

The effect of the agitation with iron upon the water is simply to cause a small quantity of iron—from $\frac{1}{10}$th to $\frac{1}{5}$th of a grain per gallon—to be dissolved. Whether the iron is really *dissolved*, in the literal sense of the term, is doubtful, but in any case, it begins to separate as soon as the water emerges from the purifier, first, in the form of ferrous hydrate, which quickly changes under the influence of the air to ferric hydrate, which is precipitated in particles more or less coarse, according to the nature of the water under treatment. From the cylinder the water passes on to a tank or other contrivance, in which the iron is completely oxidised by exposure to the air, and in which also the precipitate is allowed to settle. At Antwerp and other places, where the earliest applications of the process were made, a tank or reservoir existed before the purifiers were applied, and was consequently utilised. In more recent plants, where the works have been designed specially for the process, the expensive settling tank has been replaced by a trough or flume, along which the water runs on its way to the filters.

From the settling arrangement the water passes on to the filters, which are sand beds of ordinary construction, and call for no particular remark, except that the sand need neither be specially fine nor of great depth. Through the filters the water passes at the rate of from 80 to 100 gallons per square foot per 24 hours, and emerges pure and free from any trace of iron. It is always desirable to have some means of regulating and measuring the delivery of each individual filter, in order that a uniform speed may be maintained with all; but I do not propose to go into details of this matter.

It was formerly considered that the iron had a more or less pronounced *chemical* action upon the dissolved organic impurities of the water; the oxide formed was considered to act as a carrier of oxygen, by means of which the organic matters were actually burnt up and destroyed. It is tolerably certain now that the real action is one of coagulation, the formation of a precipitate in the water tending to throw out of solution the dissolved organic substances. It is well-established that the formation of a precipitate has such an effect; it is, for example, a common practice to purify water by means of alum, when a gelatinous precipitate of hydrate of alumina is formed, which entangles suspended particles, and also attracts substances in solution. Another example may be found in the effect of Clarke's softening process upon water. The precipitate of carbonate of lime, formed during this process, acts in a similar way, and a water softened thus is always found to have lost a large proportion of its organic matter.

We have also direct evidence that the action of the iron is of this nature. Many analyses have shown that water undergoes no perceptible alteration, as regards its organic matter, by merely passing through the revolving cylinder. It may, of course, be said that the time during which the water is in contact with the iron (three to four minutes) is too short to allow of any appreciable amount of oxidation, which may, nevertheless, take place afterwards; but that this is unlikely, is shown by some most interesting experiments made by Dr. Phillips, a well-known American chemist, upon the water of the Allegheny river. This gentleman allowed water treated by the iron process to subside until perfectly clear, and analysed both the supernatant water and the precipitate, as well as the original water. The amount of organic water in the precipitate, plus he small amount remaining in the settled water, was almost exactly equal to that conained in the original water, the amount estroyed being consequently insignificant.

Another argument against the oxidation heory is the fact that the amount of nitric cid in a water is usually diminished during he process, whereas if the organic matter ere oxidised the nitric acid would probably e increased.

It may, therefore, be considered certain that he organic matters are not burnt up or deroyed, but that they form, with the ferric hydrate, insoluble compounds, so to speak, hich are removed from the water under eatment by settlement and filtration.

This view of the action of the iron process pon the organic impurities of a water applies ually well to its action upon microbes. The application to water analysis of methods of estimating the number and determining the nature of micro-organisms has now become universal, and has proved of the greatest value to those engaged in the investigation of purification processes. The mere enumeration of the microbes in any particular sample of water is, unfortunately, the least definite of the data of a water analysis, as very great variations in the results are brought about by small alterations in the process. Thus, for example, in Dr. Percy Frankland's book on the "Micro-organisms in Water," a Table is given in which is shown how great is the variation in the number obtained, when the same water is cultivated in media of different degrees of alkalinity. The temperature of incubation, and especially the time, also influence the results to a very great extent.

Without going at length into the question, I should like to point out briefly that there are two methods of enumeration commonly met with. I will call them, for the purposes of this paper, the "English" and "French" methods, respectively. They mainly differ in the time during which the cultures are allowed to develop. In the "French" method, the sample to be examined is diluted with sterilised water, to an extent regulated by the supposed richness of the water in microbes; a measured quantity of the diluted sample is then distributed drop by drop into a large number of tubes of sterile broth; the number of microbes in the water is estimated by observing, after maintaining at a particular temperature for some days (often fifteen or more), how many of these tubes have become turbid, it being assumed that each turbid tube has received one microbe, and multiplying the number of tubes thus found turbid according to the extent of the dilution.

In the "English" method, the measured quantity of water is added to a quantity of jelly, made with broth and gelatine previously sterilised, The jelly is gently warmed to liquefy it, the sample added, and the mixture poured out into a flat plate or dish, where it is allowed to set. It is then set aside for three or four days, when points of growth appear upon the gelatine plate, which can be easily counted, it being assumed that each point of growth shows the presence of one microbe. It is not, however, usually possible to keep these cultures long unless the number of colonies is very small, as some of them liquefy the gelatine and rapidly spread over the plate.

The "French" method admits of a "mixed"

process, in which gelatine is used, which differs in no respect from the "English," except that a greater degree of dilution is practised, and the cultures are kept under observation for a longer time.

Now of these two methods of proceeding, the "French" yields much higher results, partly owing to the greater time of incubation, and partly to the higher temperature employed. I must ask you to bear this in mind in considering results obtained by one or the other process.

The absolute number, then, of micro-organisms is not in itself a datum upon which one can rely in judging the character of a water, unless the number obtained be very small. But the enumeration of microbes becomes of the greatest value in estimating the efficiency of a process of purification, because one can examine both the original and purified water under the same conditions, and whatever may be the *absolute* figures obtained, the *relative* figures convey reliable information.

I will add as a very rough guide to the number of microbes considered not excessive in a water, that it is generally considered by those employing the "English" method, that the number should not exceed 100 per cubic centimetre. For the "French" method, the limit is naturally very much higher.

Returning from this digression to my subject, various explanations of the effect of the iron process upon microbes have been advanced; but I consider that the coagulation theory applies here just as in the case of chemical improvement. The microbes are entangled in the gelatinous precipitate, and either subside with it to the bottom of the settling tank, or remain behind upon the surface of the filter. Moreover, the film of oxide which covers the surface of the sand appears to act like a Chamberland-Pasteur filter, retaining the microbes, while allowing the water to pass freely.

A very important feature of the iron process consists in the rapidity with which perfect results are secured. A sand filter of ordinary construction will remove a very large proportion of the microbes in a water, when its surface has become sufficiently blocked by the layer of matter, living and dead, separated from the water being filtered. To obtain this result, however, it is necessary to work the filter for days, delivering all the while imperfectly filtered water, until this layer has time to form. With the iron process, however, no such thing occurs. The practice is, when a filter is restarted after cleaning, to refil it from below with purified water from another filter, until the surface of the sand is submerged; and then to admit from above water direct from the outlet of the purifiers, containing in suspension the whole of the iron oxide supplied to it. This turbid water is then allowed to settle upon the surface of the sand, when it immediately forms the desired film. Then the filter is set to work, and yields from the first water containing the minimum number of germs. All the water afterwards supplied to the filter is settled as clear as possible, in order to prolong to the greatest extent the time from one cleaning to the next. The film thus formed is quite clean, and is never slimy or offensive.

As an illustration of the point referred to above, it may be stated that some official analyses were conducted at Antwerp in the autumn of 1893, by Dr. Van Ermenghem, the eminent bacteriologist of the University of Ghent. Samples were taken hourly from the outlet of a filter, beginning at four hours after starting, which allowed time for the water already occupying the pores of the sand to be replaced by fresh water. The number of microbes found four hours after starting was 30, and samples taken at short intervals after yielded from 25 to 52 microbes per cubic centimetre, with the exception of the sample taken at the seventh hour, which yielded 320. That this was probably due to some accidental cause is shown by the sample one hour later, which yielded 25.

Any accidental disturbance of the surface of the sand of an ordinary filter would, without doubt, seriously impair its microbiological efficiency. The iron process, however, is wonderfully tolerant, and affords a great safeguard in case of such an occurrence. I may illustrate this by continuing the history of the filter above referred to. After working for a fortnight, the film was purposely broken up by dragging a chain over the surface of the sand. One hour after this operation, a sample was taken and found to yield 40 microbes per cubic centimetre, and subsequent hourly samples yielded from 31 to 67 microbes per cubic centimetre. The original water, I may add, usually contains from 20,000 to 100,000 microbes per cubic centimetre.

The only modification of any importance which has been made in the process since its first application is aeration of the water when in contact with the iron. Various schemes have been devised for this object, air being sometimes blown into the ordinary cylinder, or a modified apparatus being made which continually exposes the iron to the action of the atmosphere. These modifications have proved of value in some cases, particularly when waters are much contaminated with vegetable matter, but I have not space to refer to them in detail.

The first installation of the Anderson process was at Antwerp, where a very impure and difficult water has to be dealt with. As the works were not in the first instance designed for this process, which was added afterwards, it cannot be considered a model installation. Nevertheless the results obtained are excellent, and Antwerp has now a favourable experience of ten years to show. I have already quoted some recent results obtained by an independent expert, showing the extent to which micro-organisms are removed.

The Antwerp purifiers were started in 1885, and the following year the process was started at Gouda, in Holland. The supply is drawn from the River Ysel, which, in flood time, is very peaty and difficult to treat. The purifier (a 9-inch) is placed on the first floor of a building which serves as both engine-house and water-tower, and the water, after being pumped through, falls again to the level of the engine-house floor, where it drives a reaction wheel, whose motion is communicated to the cylinder by a long vertical spindle. The system here has effected a great saving in working cost, the purification being effected much more cheaply by metallic iron than by ferric chloride, which was formerly employed here, with the additional advantage of adding nothing to the water.

In 1887, a 14-inch purifier was erected at Dordrecht, in Holland. This town is supplied from the River Merwede, and the water is at times very difficult to treat. The purifier was erected under guarantee, and the results being satisfactory it was adopted. Like Gouda, this purifier is driven by a reaction wheel.

The next installation I shall mention is that at Agra, in India. The supply is taken from the River Jumma, which at this point is considerably polluted. The success of the Antwerp installation induced Mr. A. J. Hughes, who was the sanitary engineer to Government for the North-West Provinces and Oudh, to try some experiments to compare the effect of simple sand filtration with sand filtration after previous agitation with iron. These experiments were made upon a practical scale, and demonstrated clearly the superiority of the iron process, even when the filter was delivering at a much greater speed. Subsequently three 10-inch purifiers were erected, capable jointly of purifying 2,000,000 gallons of water daily, at the ordinary contact of 3½ minutes, and have now been in use some years.

The purifiers are in the same building as the pumping engines, close to the river bank, and are driven by a small separate steam-engine. After passing through the cylinders the water is conveyed to two large subsiding reservoirs and thence to the filters, which are three in number, each 200 feet long by 100 feet wide; two of these can filter 2,000,000 gallons a day at the rate of 50 gallons per square foot per 24 hours. The sand used in the filters is dredged from the bed of the Jumna and is by no means of good quality, being friable and containing a large proportion of mica. The results obtained are nevertheless excellent. One noteworthy point about the Agra installation is the completeness with which the water precipitates, as the microbes, in a special series of experiments, were found to have dropped almost to the lowest point even before filtration. I quote here the figures obtained in these experiments:—

	Microbes per c.c.
Jumna River	700
Stand post, Pumping Station	8
Well of filter, No. 1	2
Well of filter, No. 2	6
Top of filter	6
Settling tank, 36 hours settlement	6

The small number of microbes in the river water is noteworthy. Mr. Hankin, the Chemical Examiner to the North-West Provinces, has remarked that this is a characteristic of Indian rivers, possibly due to the large amount of bright sunshine.

The average of the water at Agra, for the first five months of last year, is as follows:—

	Microbes per c.c.
River water	1,220
Purified water	12

The average chemical results of the purified water for the same period is:—Free ammonia, nil; albuminoid ammonia, ·04 per million. The average of the river is not given.

These results are all the more satisfactory, as, during this period, owing to alterations to the sand of one filter, a speed of 90 gallons a square foot was often employed.

The installation at Monte Video, with which

I shall next deal, was erected early in 1890. As at Antwerp, the works were not designed—in the first instance—for the purifiers, which were added after the first settling tanks and filters were built. The source of supply is the River Santa Lucia. The pumping station is about four miles from the village of Santa Lucia, and about forty miles from Monte Video.

The pumping station is placed beside the river, and the water is raised by a Worthington pump to the inlet tank supplying the three 14-inch purifiers, which are placed in a separate building above the settling tanks. The water from each purifier, after passing through the cylinder, is caused to drive a water-wheel, from which the power is transmitted by a pitch chain to the gearing of the machine. In addition to driving the cylinders, the wheels also drive air-pumps, fitted to each machine, which force air through the water while in the cylinder, and afterwards still further aërate it after leaving them. The object of this is to increase the action of the iron; the water of the Santa Lucia, which presents no special features in ordinary times, becoming exceedingly bad in time of flood, being loaded with vegetable and clayey matters which are difficult to remove.

The settling tanks are four in number, with a total capacity of nearly 11,000,000 gallons of water. The filters are five in number, each 12,000 square feet in area. They are protected from the sun by a wooden roof covered with tiles. The sides are open, so that a free current of air can always pass over the surface of the water. From the filters the water passes to the clear water reservoir, which has a capacity of 3,000,000 gallons. From this reservoir it is pumped about 22 miles to storage reservoirs of about 10,000,000 gallons capacity, whence it is distributed by gravitation to the town.

The quality of the water is very good even in flood time. I have here the official report of the municipal laboratory on the supply during 1894, which is in every respect favourable. Microbiological analyses have been made regularly during the greater part of the year, and the results may be considered quite satisfactory, especially when it is borne in mind that, owing to the large storage reservoirs, some days may elapse after purification before the water reaches the city.

In 1892, an experiment on a large scale was tried with the process on the Severn water at Worcester. Purifiers were erected at the waterworks to deal with the whole city supply, and for six months the system was kept in operation. The process was investigated here by Dr. Dupré, who made a long series of chemical and microbiological analyses, which included the period during which the purifiers were in use, as well as a considerable time before, when sand filtration was employed alone. Dr. Dupré found that the purifiers effected a considerable improvement in the chemical quality of the water, as compared with sand filtration, and a very great improvement in the microbiological quality. He also formed the opinion that the revolving purifier system was much safer than simple sand filtration, because accidental disturbance of the sand or excessive speed of filtration had very little bad effect on the results.

I now wish to bring to your notice the history of the reception of the iron process in France.

About five years ago the process attracted the attention of the largest and most influential water company in France—the Compagnie Générale des Eaux, of Paris. After having investigated the process at the places where it had already been adopted, the Cie des Eaux wished to have further proofs, and the Revolving Purifier Company, Limited, which was formed in 1889 to work the process, undertook to demonstrate its efficiency in dealing with the water of the Seine, taken below Paris, at the pumping station of the waterworks of Boulogne-sur-Seine, close to the Pont de Sèvres. Accordingly a complete plant was erected, capable of dealing with 100,000 gallons of water in 24 hours, consisting of a 6-inch purifier, delivering into a long settling trough, and filters to correspond. This plant ran for some months, and amply proved the correctness of all that had been claimed for the process to the complete satisfaction of the Compagnie des Eaux, who closely followed the trials, and made all requisite analyses.

The next step was the application of the process to the whole of the water pumped from these works. The trial plant was removed, and two 10-inch purifiers erected, capable of treating rather more than 1,000,000 gallons daily. The purifiers deliver into a settling trough, consisting of several channels side by side, formed by the sub-division of a tank by a number of parallel walls, so that the water flows along one channel, back by the next, and so on until it reaches the channel communicating with the filters. Such a settling arrangement, although the water is never at rest, appears to be as efficacious as the subsiding reservoirs commonly in use, especially with the modifications which I shall describe presently, and is much less expensive.

The Boulogne-sur-Seine works, unlike those I have already alluded to, were designed expressly for the Anderson process, and the results obtained there have been most gratifying. The Seine water at the point of intake, though not very heavily loaded with organic matters, is very rich in microbes, the average result of some analyses I am presently going to quote, indicating the presence of nearly 400,000 per cubic centimetre. Dr. P. Miquel, the eminent head of the bacteriological department of the Observatoire de Montsouris, was commissioned to investigate the working of the process here, and during the period from February to July, 1893, took 22 sets of samples for analysis, being allowed to take them at any time he wished without advising the Compagine des Eaux. The purified water was on each occasion compared with the spring water of the Vanne, which is considered to be the model of what a drinking water should be. The result of his analyses is truly surprising. He published the figures in the annual report of the Observatoire, and it appears that of the 22 samples of purified water examined no less than 11 were either equal to or superior than the water of the Vanne on the same date, as regards bacterial purity, while the average of the whole set of samples of purified water gave a figure which does not greatly exceed the average of the Vanne water. The average number of microbes removed was 99·57 per cent. of those existing in the original water.

It is hardly necessary to add that the purified water at Boulogne-sur-Seine is clear, brilliant, and colourless at all times. I may however remark that the speed of filtration habitually employed there is from 4·5 to 5 cubic metres per square metre per 24 hours, corresponding to 90 to 100 gallons per square foot per day, and that the thickness of the sand, which is normally 50 cms., has been reduced by successive filter cleaning, without replacing the sand removed, to a depth of only 15 cms., or 6 inches, without impairing the quality of the water in the least.

The Boulogne works have proved nevertheless to possess some inconveniences, not as regards efficiency of purification, but as regards ease of working. The chief of these is in the arrangement of the settling trough. In the first place, it is impossible to clean out any portion of the trough without stopping the entire works, and, secondly, the settlement is not efficient enough. The Boulogne filters only run three weeks after cleaning; this period is very constant, and almost independent of the state of the river: but it is very desirable to increase the life of the filters as much as possible. It should, however, be stated that the construction of the filters leaves something to be desired, as there is a considerable initial loss of head, due to the arrangement of the outlet pipes. The experience of Boulogne has been utilised to the fullest extent in the design of some of the later works, to which I shall come presently.

Boulogne, being the first works really designed throughout to work the Anderson process, it was of great interest to see how the working expenses came out. It is satisfactory to find that the cost of purification is very low; and I am enabled to give detailed figures of this for the year 1893:—

	Fcs.
Iron (at 7 fcs. per 100 kilos.) ..	350·00
Cleaning decanting reservoir ..	180·00
Cleaning filters (5 fcs. per man per day)	780·00
New sand	300·00
Coal, oil, waste, &c.	1,400·00
	Fcs. 3,010·00 or £120

The average quantity of water purified daily is 1,100,000 gallons, hence the cost per million gallons is very nearly 6s.

The next installation I shall mention is that at Libourne, which was really decided upon before Boulogne. Here there are three six-inch purifiers, delivering into a long settling flume, which runs across the ends of the filters. These are five in number, each 12 metres long by 10 wide, covered in with masonry vaults. The output is about 2,000 cubic metres, or about 450,000 gallons daily, and the quality of the water is excellent. The only drawback is that the filters choke too quickly, owing to the insufficiency of the settling arrangement, and to a similar fault in the construction of the filters to that already alluded to at Boulogne.

The installation at Nice is a very interesting one. Nice and the neighbouring towns of Monaco, Mentone, and Villefranche-sur-Mer, derives its water supply from an irrigation canal—the Canal de la Vesubie. A reservoir had been built on the slope of a mountain for storing and distributing the water, and when it was decided to improve the quality of the supply, the new works were simply placed on the top of the existing reservoir, to which a story was added, so to speak, forming another reservoir two metres deep, which is divided into five compartments of varying size. The largest forms a subsiding tank, the other four, which vary from 400 to 500 square metres in area, form the filters. The whole reservoir, in plan, is irregularly shaped, a long parallelogram with smaller parallelograms removed from two opposite corners. In one of the re-entrant angles thus formed is the purifier-house, at the opposite end of the reservoir to the subsiding tank. The purifiers are three 10-inch, two being generally in use and the third in reserve. The water delivered from the purifiers is conveyed in a trough to the subsiding tank, from which it passes to the filters, and thence to the storage reservoir below.

The purifiers are driven by water power, there being an effective head of about 17 metres. The water passes through a turbine on its way to the cylinders. The turbine drives the purifiers and an air-blower, which is used to pass air through the cylinders, and also to aërate the water on issuing from them. Incidentally the blower is made to perform another function, namely, that of keeping the speed of the turbine constant when varying quantities of water are passing. This is effected by the aëration contrivance in the outlet tank, which consists of a perforated box connected with the blower in such a way that it can be raised or lowered in the tank, thus varying the head against which the air must be blown, and, consequently, the load on the turbine. If, for example, the quantity of water passing through the purifiers should be increased, the perforated box is submerged more deeply, and thus the speed of the turbine can be kept constant.

The total output of the Nice works ranges from 6,000 to 8,000 cubic metres a day, or from 1,300,000 gallons to 1,700,000 gallons. The installation works very well indeed, and the purity of the water is all that can be desired.

The installation at Constantinople is, again, a case in which a large plant has been put down, after a trial on the spot with a small apparatus. The supply is derived from the Lake of Derkos, which is situated near the Black Sea, about 42 kilometres from Constantinople. A purifier capable of treating about 10,000 gallons a day was tried here about five years ago, and, after long and exhaustive tests, the system was finally adopted. The installation consists of three 10-inch machines, two in work and one in reserve, as at Nice. These discharge into a subsiding reservoir divided by walls into compartments, the water flowing continuously from one to the other; there are five filters. The output of the works is about 5,000 cubic metres, or a little more than 1,000,000 gallons a day, and the results are in every way satisfactory.

Returning now to Paris, and the results obtained at Boulogne, the next step in advance was the application of the process to the supply, taken from the Seine and the Marne, of 57 of the suburban Communes of the Department of the Seine. After a considerable time spent in preliminary negotiations, a contract was signed early in 1894 between the Prefect of the Seine, acting on behalf of the Department, and the Compagnie Générale des Eaux. The Compagnie des Eaux in this contract undertook to construct works on the Seine and the Marne, above Paris, capable together of purifying 70,000 cubic metres daily, or nearly 15,000,000 gallons, and to remove 99·6 per cent. of the microbes in the original water. These works were to be in full going order by January 1st of this year. The total cost was estimated to be 12,000,000 francs, this sum including the cost of removing the existing pumping stations and laying mains. The Compagnie des Eaux have advanced the money, which is to be repaid in annual instalments of a fixed amount. This annual payment will be derived from the sale of the water, and in case the amount in any year cannot be made up from this source, the Conseil General de la Seine guarantee to make up the sum required.

In order to provide for the repayments the Communes concerned have agreed to raise the price paid by the consumers by 1 centime per cubic metre, or about ½d. per 1,000 gallons. Fifty-seven of the 58 Communes of the Department have decided to accept the new service on these terms, and the scheme has been accordingly carried out.

The purified river water is supplied from three pumping stations, situated respectively at Choisy-le-Roi, on the Seine, and at Neuilly-sur-Marne and Nogent-sur-Marne, on the Marne. The three installations are all made on the same general plan, and I shall select that at Choisy-le-Roi for description. These works are designed for a quantity of 30,00 cubic metres, or 6,500,000 gallons daily, wit provision for almost indefinite extension i necessary. They have now been about fou months in operation. The works on the Marn were not quite so well forward, but all were a work at the time specified.

In the design of these works full advantage has been taken of the experience gained at Boulogne-sur-Seine, and it is difficult to believe that any further improvements can be made in the future, as every detail has been so skilfully planned.

The main pumping engines scarcely come within the scope of this paper. It will be sufficient to say that in addition to the main pumps they also work the low lift pumps which supply the water to the purifiers. The intake of the water is situated well out from the river bank, and the water is taken a little below the surface. It is then pumped to the purifiers, which are six in number. The purifying part of the works may be divided into two symmetrical halves, and the extensions of the installation referred to above may take place on either side. Thus the six 14-inch purifiers are placed three on each side of the centre line, and parallel to it, in a building in which space has been left for two more purifiers on each side. Each cylinder discharges into a separate small outlet tank, which is fitted with an adjustable overflow, in order to maintain the level of the water in the purifier at any desired height. The machines are driven by a small separate steam-engine, which also drives an air-blower. By this means a constant current of fresh air is introduced into each cylinder at the outlet end, and after passing over the surface of the water escapes by a special pipe at the inlet end. The charge of iron in each purifier is 2,130 kilos., or just two tons. The iron used here consists of horse-shoe nails which have been rejected on account of some imperfection in form, and costs 75 francs the French ton, delivered on the works.

The outlet tanks of the purifiers discharge into a series of shallow troughs in steps running the whole length of the building, and the water flows from one to the other in a series of cascades. These cascades, and, indeed, the whole of the light division walls, and much of the heavy masonry, are built after the method due to M. Monnier, of a framework of iron lattice work, covered with cement, which is strong, and, at the same time, cheap, and very neat.

After the cascades, the water passes to the settling system, which requires a more minute description. It consists of a series of troughs running parallel to the cascades, in which the water follows a to and fro course from one trough to the next. The system is in three divisions, to each of which a special name is given. The first division is called the "Dégrossisseur," and is a plain trough two metres deep, in which the heavy particles of the precipitate at once subside. The second division is for what they term "Précipitation," and consists of a trough of the same depth, across which baffle plates are placed at short intervals, so arranged that the water passes alternately under one plate and over the next.

The third division is called the arrangement for "décantation." It is, as before, a trough two metres deep, but furnished at intervals with pairs of plates placed close together. The plate on the side from which the water flows is fixed to the bottom, and terminates just below the surface; while the second plate projects above the surface, and does not reach the bottom. Thus these pairs of plates always select the surface water, which passes down the narrow space between them with a comparatively high velocity; thus the solid particles in the water are directed towards the bottom of the trough, and as the water only rises slowly, tend to remain below.

This settling system is constructed in sections in such a way that any one section can be emptied and cleaned without stopping the others. It occupies very little space, but is clearly a great advance on a simple trough as first employed. The works at Choisy have hardly been running long enough to enable the effect to be fully appreciated, but this much is certain. The water reaches the filters so clear that the sand can be readily seen through a depth of a metre of water, and observations made of the rate of choking indicate at least six weeks as the life of the filters, whereas at Boulogne, as already observed, they only run three weeks.

After passing the settling system, the water is conducted in channels of iron and cement to the filters. These are fifteen in number, in five sets of three, each being 625 square metres in area. When all are in use the water can be filtered at the rate of 3·5 cubic metres per square metre per 24 hours—about 70 gallons per square foot—but as has been shown at Boulogne, this rate may be greatly exceeded without impairing the results.

The filters do not present any striking peculiarity in construction, except that the main drain for the filtered water passes diagonally across from corner to corner, and that the bottom of the filter is not flat, but raised as it recedes from the drain, so as to cause water from every part of the filter to reach the outlet as nearly as possible at the same time.

Upon the cemented bottoms of the filters are laid bricks on edge so as to form channels. Above these, and roofing in the channels, are laid selected flints, above these smaller and smaller flints, and finally 50 cms. of sand. The sand is obtained from the Loire, it is not specially fine, but clean and sharp, washing readily. This filling permits of a depth of one metre of water over the sand.

The filters are provided with inspection and regulating chambers, in which are the necessary valves and apparatus for the regulation of the speed of filtration, the measurement of the head on the filter, for quickly running the water off when the filter has to be cleaned, and for the admission of pure water from below when restarting. The filters are so grouped that one chamber as a rule contains the valves and pipes relating to two filters.

The water after filtration is directed to a covered clear water reservoir, whence the main pumps are supplied.

Opposite the purifiers, on the far side of the filters, are three platforms for washing sand.

The entire installation occupies very little space, considering the output of the works, about 6,500,000 gallons a day, and the filters and settling arrangement can be extended laterally if necessary without interfering with the working.

Although the plant has only been running about four months, the quality of the water is excellent. It is clear and brilliant when viewed through a depth of 2½ metres. Careful examinations as to the content in microbes are continually being carried out, samples from every filter being examined, and the chemist has reported that some of the filters are delivering water which has caused no growths on his culture media after several days' incubation, while the average results from all the filters are very low. The Compagnie des Eaux will shortly invite Dr. Miquel, to whose work in connection with Boulogne I have already referred, to carry out a series of analyses at Choisy, and we shall await the announcement of his results with the deepest interest.

The works at Choisy are intended for the supply of the communes to the south of Paris, and those at Neuilly-sur-Marne and Nogent-sur-Marne for the supply of those to the north and north-east.

There is another group of suburban communes occupying the peninsular of Gennevilliers, which is supplied by another company, La Compagnie des Eaux de la Banlieue. This company have also studied the question of improving the supply, and in July of last year concluded with the Department of the Seine a contract precisely similar to that already referred to as entered into by the Compagnie Générale des Eaux. Their works are to be established at Suresnes, below Boulogne, the experience of this latter place having proved that the water of the Seine taken at this point and submitted to the Anderson process will furnish a pure and wholesome supply. The quantity of water t be treated here is not known with certainty It is probably about 5,500,000 gallons a day but the company have not yet given the orde for their purifiers.

There is a third supply in Paris for which the iron process will almost certainly b adopted, and which will be of the greates importance; but the adoption is not ye definitely decided on, as the authorities ar awaiting the results of Choisy before takin the final step. I can therefore only say tha the plans are all prepared, and we expec shortly to hear that the affair is settled.

This then brings me to the close of my sub ject. There is of course great similarit between the various installations I hav alluded to, the differences being mainly i details which time would not permit me to g into, and hence it has been difficult to mak this paper as interesting as I should hav wished. I hope, however, that I shall hav succeeded in showing you that the Anderso process is steadily making its way, and tha experience has fully justified the high opinio of its merits formed by its striking and imm diate success at Antwerp.

DISCUSSION.

The CHAIRMAN said he saw this process at wo at Antwerp many years ago, and he was satisfi that for certain descriptions of water it afforded very useful method of purification. Some few yea afterwards he was asked to go to Florence to advi on the sanitation of that town, and then suggest the adoption of the Anderson process for improvi their water supply; but they were then much set obtaining a supply from near the baths of Lucc which was to be perfectly pure, and the suggestion w not adopted. Unfortunately, pecuniary difficulties h prevented the carrying out the more ambitious schem and the Florentines had now great difficulty in getti good water, so that he should not be surprised if th finally adopted this process. What astonished hi was that, after the excellent reports by Dr. Dup and other independent authorities, many towns in England had not taken advantage of this process. He did not say it gave a perfect water, but it gave one which was perfectly wholesome, and had been proved to prevent the spread of disease, as had been shown in many Continental towns.

Dr. Dupré, F.R.S., said he had, some years ago, watched the process on behalf of the town of Worcester, where some million gallons per day were purified. He found it to work admirably in every respect. He examined the water when there was only sand filtration, and found the microbes were from 1,300 to 3,000 per cubic centimetre, but directly the iron process was applied, the number sank to 100, very rarely exceeded that, and sometimes went down as low as five. They all knew now that the effect desired was not so much to remove chemical substances in solution, as to remove microbes. He did not mean to say that water might not be foul and objectionable, irrespective of microbes, but the main advantage of this process was that it removed the microbes so completely. This could also be done by very perfect sand filtration at the rate of 4 inches per hour, but if the rate were varied by half an inch, or an inch, the whole process broke down, and you jumped at once to hundreds of microbes. With the iron process you might vary the rate from 4 inches to 20 inches without, apparently, affecting the number at all. The film of iron which was formed was such a perfect medium, that even continued disturbance in the rate did not seem to affect the result. That was the great advantage, that it was to a large extent independent of care and skill; whilst perfect sand filtration required unremitting attention and care, which was almost impossible to secure. It was often said that the efficiency of a mode of purification might be tested by the per-centage of microbes removed from the original water, but that was an error. When the filtration was perfect there ought to be no relation whatever between the result and the original pollution; whether there were 1,000 or 1,000,000 in the original water, there ought not to be more than a very small number when it was puri-ied. That was clearly established by Koch, whose name he was surprised to find was not men-ioned in the paper. He showed that a perfect ilter ought to remove all the microbes coming upon t, and that those which were found afterwards were hose only which grew in the sand at the lower part. f they rose above 100 per cubic centimetre, the filter was defective, that being the greatest number which ught to be produced in the sand, with a rate of inches per hour. Although he reported in favour f the system at Worcester, it was not adopted, one bjection raised being, he believed, the noise, some mportant inhabitants having their residences near he waterworks, and finding the noise an annoyance, specially at night. Another objection was the olour. The water before was always slightly turbid, nd the Severn at Worcester was very peaty. Now if a coloured water were turbid, the colour was not so apparent, and, consequently, when this water was purified and made clear, people thought it was darker than before, though in reality it was less dark. The London water companies conducted their business very well on the whole, but he had found some samples to contain as many as 10,000 microbes per cubic centimetre, and 1,000 was not at all uncommon. Another advantage of the iron process was that, after cleaning the filter, it could be used immediately; but you could not do that with a sand filter. Twenty-four hours ought to elapse before the water was used, and during that time the water ought to run to waste. That might be done when the supply was in the hands of a municipality; but you could not expect trading companies to submit to such a loss. Koch said the water should always run to waste when there were more than 100 microbes in it, but he feared, if the water companies followed that rule, we should soon have a water famine in London.

Dr. Anderson, F.R.S., said this paper had shown what he did not show in his original paper, viz., what was the true cause of the purification, and it explained a good many anomalies which were then inexplicable. The extraordinary power which iron had of precipitating by coagulation was very well shown in the waters of the Nile. In flood time they would not settle in any reasonable time, and you could not filter the water except through a porcelain filter. The best Swedish filter paper would allow a great deal of the finely divided mud to go through; but if treated in the revolver and then passed through a layer of sand 3 inches thick, it became beautifully bright and clear. He did not know what it was which prevented this process from being adopted in this country. It seemed strange that it should be used in Belgium, Holland, France, Turkey, and India, but not here. He believed one reason was that English people did not care so much about clean water for ordinary purposes; the use of domestic filters for drinking water being so common. At Antwerp they did not use domestic filters, and they expected to get from a source which was little better than a sewer a water which could be put upon the table and look bright and colourless. That in fact was the feat which had been performed, both there and elsewhere. He thought it was safer to use water from a river, even if polluted, after purification in this way, than to use water untreated from the purest river or deepest well, because, after it had been purified, it was not afterwards exposed to contamination; and they knew, from experience at Caterham, Worthing, and other places, that deep-well waters were not at all safe from contamination, by leakage through the soil, and other adventitious causes. Even the Vanne water, which in Paris was held up as the model, was shown to have at times a very large number of microbes. Dr. Dupré had explained that the few microbes which were found after efficient filtration were due to growth in the sand at a lower level than that at which the separation of deleterious matter took place; and that might explain why Antwerp had been so free from epidemics of cholera and other diseases since these works had been in operation. He hoped the reading of this paper would lead to more attention being given by English engineers to this process, in which, he might say, he had no financial interest whatever. It was not only safe, but very cheap; and perhaps that was one reason why it was not in much favour. It seemed much more heroic to bring water many miles from some lakes than to put up a small works on the spot, without any great outlay. His son had omitted to mention the name of Mr. George Ogston, who was greatly concerned in the inauguration of this matter, the idea having, he believed occurred to him and Sir Frederick Abel at the same time of getting over the difficulty of the clogging of spongy iron filters in the way described. His own share in the matter was the designing of the mechanical appliances.

Mr. PARKER RHODES said he had always understood that the fact of water being bright and clear was by no means proof of its purity. He was surprised to hear that this process, though in use abroad, had not been adopted in England; but he was not quite sure that it would be for the benefit of the community to introduce it, seeing that Chalybeate water, or water containing iron, though recommended in certain cases, was not always beneficial.

The CHAIRMAN reminded Mr. Parker Rhodes that the iron was all removed before the water was delivered to the consumer.

Colonel ALLAN CUNNINGHAM said the interesting explanation of the theory of this process reminded one of similar instances in common life, such as the clearing of soups by white of egg, and the fining of beer, and wine, &c. He should like to know the size of the apparatus, and also if there was much or any waste of iron in the process. If so, was it due to the iron being carried away in bulk by the water, or to its conversion into ferrous oxide. Also, what was the the rate at which the purifier revolved. The account of the Paris installation was very interesting, but he thought it rather strange that the intake in one instance should be at Sévres, which he believed was not far from the outfall of the sewers.

Mr. BLAKESLEY said he had the pleasure of hearing Dr. Anderson read a paper on this process at the meeting of the British Association about five years ago, and he then asked him what effect was produced by it on the inorganic impurities. He understood from him that that point had not been very much investigated, but it was one of some importance. There were other processes for purification, such as that by lime, and if that were equally efficient in removing microbes, it possessed the great advantage of softening the water. He had tried various experiments on water from different sources, with iron, and found that although there was a softening action, it was not very decided, and that very soft water was hardened. It was a great drawback to London that the water was so hard, especially that which was freest from microbes—the Kent. They knew that chalk water could be softened, as was shown at Canterbury, and he considered this point was quite as important as the elimination of microbes.

Mr. BLOXAM said he had hoped that Dr. Dupré would have given some figures showing the chemical improvement of the water by this process, but he gathered that no experiments of this kind had been made. With regard to microbial purification, it was a question whether this process was more effectual than mere sand filtration. It was well known that by mere agitation with a number of inert substances, exerting no chemical or bacteriological action, a lot of insoluble matter settled down, and carried with it the bacteria. Dr. Percy Frankland had shown that by agitation with coke the microbes could be reduced exactly 100 per cent. Other materials might be quoted, which also acted not quite so efficiently—chalk, 77 per cent.; spongy iron, 93 per cent. The report of the water examiners for London, Professors Crookes and Dewar, for December, 1895, stated tha whilst Thames water unfiltered exhibited 3,25 colonies per cubic centimetres before treatment, tha after filtration the mean of five samples was 74 Unless there were evidence that this, or any othe specific process, had some distinct advantage ove ordinary filtration, he thought they should withhol their judgment. Dr. Dupré said the microbes mus be reduced to 100, or less; but even a water perfectl free from micro-organisms, when it got into th circulating system, was exposed to attack by suc organisms, some of which might be pathogenic; an the question was whether, if such water, thoug bright, had a considerable quantity of organi nitrogen and carbon in solution, those organism would not find it a suitable medium in which to gro and propagate.

Mr. L. DAMPIER said he gathered from the pape that this process had the effect of reducing the nitri acid in water; if so, it was of great interest t brewers, whose great endeavour was to get rid of th nitrates. Only a week ago a question was aske about this in the *Brewers' Journal*, and the answ was, that there was no known method of taking th nitrates out of water. If Mr. Anderson could gi any figures on this point he should be obliged.

Dr. CORFIELD said he was glad to hear M Anderson say that the removal of organic matter ha nothing to do with the reduction of the oxide and r oxidation, but was, in truth, a mechanical proces There was little doubt that the oxide of iron, whi forming, removed by a sort of adhesion the organ natter, which then precipitated. With regard to he microbes, he considered people were going wild ın this question. Microbes did no harm in the vater; on the contrary, they did a great deal of good. t was simply because they suspected—often with ;ood reason—that amongst these microbes there vere certain pathogenic organisms that they were so nxious to get rid of them. The whole difficulty rose from taking water which they ought not to ake for domestic purposes. He protested against)r. Anderson's suggestion of taking foul water and urifying it to get rid of the microbes, the majority of hich were extremely beneficial. Water containing athogenic organisms ought not to be used at all.

The CHAIRMAN having proposed a vote of thanks) Mr. Anderson, which was carried unanimously,

Mr. ANDERSON, in reply, said he had not referred) Dr. Koch, because his work in connection with ater analysis was so universally known that it was nnecessary. With regard to the noise, in most ıses waterworks were at such a distance from the ıwn that the noise was not worth considering, but necessary it could be almost entirely removed by e use of wooden cogs to the wheels. At Antwerp, ›wever, the working of the machines was inıdible outside the building. The largest sized achine, styled the 14 inches, was about 25 feet long 6·6 inches in diameter. The waste of iron, when ınchings were employed, was almost entirely fair ıste, arising from oxidation and solution; it was ıly when the pieces got very small indeed that they ere washed out of the machine. The rate of revotion was about 6 feet per minute at the periphery the largest machine, so that it made one revotion in three minutes. The water seemed to tack the iron of the charge in preference to e machine itself; those at Antwerp showed no ;ns of wear, after ten years' use, except that re and there the shelves wore mechanically and d to be replaced. With regard to the Paris instalion, it was quite true that a good deal of sewage t into the river as it passed through the city, but it s partly self-purified before it reached the intake Boulogne, and the experience quoted had shown ıt by employing the iron process, it was unnecesy to remove the existing pumping station to another ce; the great bulk of the sewage came in at chy, further down, and just before reaching there water was purer than at any point after passing ough Paris. He had little doubt that where it ıld be applied the lime process, which purified and tened at the same time was the best thing, but the ›ense of using lime on a large scale was very great, that it was generally quite out of the question. is process only cost from $\frac{1}{14}$d. to $\frac{1}{10}$d. per 1,000 ons. With regard to Mr. Bloxam's remarks, he not been able to include more than a small tion of the figures at his command, but he should ıble to supply him with details showing that there was a very large chemical improvement, much greater than by mere sand filtration. The reduction of nitric acid was very variable, and seldom attained any great amount. He had made many analyses on this point, but had not the figures with him. As far as he remembered, they seldom removed more than $\frac{1}{2}$ grain per gallon, and often not so much. He did not think it would be a practical method of reducing nitrates unless supplied in some special way. He was glad to find that the coagulation theory had been supported. With regard to the question of microbes, they were always requested to remove them as completely as possible, and endeavoured to do so. Whether it was the right thing to do or not was a much broader question, which he was not prepared to go into.

Miscellaneous.

ORANGES AND LEMONS IN PALERMO.

Notwithstanding the cheapness with which oranges and lemons of good quality can be obtained in the English market, the growing of these popular and wholesome fruits continues to spread, so that the following facts, gathered from a recent official report, will be of interest, not only to the producer, but also to the consumer. In commerce, oranges and lemons are classified under the term of "green fruit," and are so called from their being gathered while yet green, in order to stand the voyage. Both oranges and lemons grow abundantly in the provinces of Palermo, Messina, Catania, and Syracuse; Messina is especially noted for lemons. The best oranges are those grown in the province of Catania, especially at Aderno and Biancavilla, but very many excellent and mixed qualities are found in the province of Palermo. They are distinguished as ordinary, blood, and sweet or vanilla, and mandarines. Lemons present no variety, although they have designations known to the trade. Shipments mostly go to the United States of America; as many as 429,881 boxes of oranges and 1,195,644 boxes of lemons having been so shipped in the year 1893–4, while the quantities sent to the United Kingdom are comparatively small. The wood for the construction of these boxes is imported from Trieste, Fiume, and Bangor, United States of America, and made up at Palermo into cases, boxes, and half-boxes. These are spoken of as 16, 25, 30, 36, 42, &c., according to the number of lemons in each layer. The fruit destined for the United Kingdom is in cases, and that for the United States in boxes and half-boxes. They are carefully stowed in tiers one above the other in the vessel's hold in such a way as to prevent injury to the fruit. Half-boxes only contain two layers of fruit; boxes, four and sometimes five. All, whether oranges or lemons, are wrapped in tissue-paper, with paper shavings to fill up interstices and to assist the ripening on the voyage. Naturally this fruit can never be so good as that which ripens on the tree. During the last few years, fears have been entertained that this trade to the United States will eventually suffer considerably on account of the suitability of the climate and soil of Florida and California, where the trees have been extensively introduced. It follows, that if the States can produce their home supplies, there will be little or no demand for Italian grown fruit; and, with their system of railways, their markets will be supplied with fresh fruit, which has not run the risk of deteriorating on a long sea voyage. Unfortunately, the orange crop in Florida was destroyed by the exceptionally severe cold of December 1894. This occasioned an advance of prices in the States, the effect of which was to stimulate the trade in Sicily during the past year. The growth of this trade has only been developed within the last 40 years, and since the introduction of steam it is four times or more as great as it was in the days of sailing craft. Commensurate with this increasing demand and prompt disposal of cargoes, the value of fruit in Italy has been enhanced, and this consideration has induced growers to raise their prices, to which has followed, temporarily, a marked decrease in the demand. Fruit then was shipped at exporter's risk, and this failed to answer; agents were sent over to the States to safeguard exporters' interests, as it was thought; but even this measure was ineffectual; for it was found that the former induced shippers, who have not their own agents in the country, to send their supplies to them, under promise of greater facilities, &c. In this emergency, the questionable system of money advances to shippers sprung up, in order to secure shipments, and fruit began to be put on board unfit to stand the voyage. Shipowners, in some cases, are known to have entered into contracts with shippers for certain supplies to be put on board these vessels during the fruit season in consideration of this advance, to be accounted for on settlement of freight.

The orange and lemon culture is one of the chief industries in Sicily. In some parts of the island the fruit is a source of wealth to the proprietor, and affords work to thousands of men, women, and children, in cultivating the tree, and in gathering and packing the fruit for exportation; besides, there is much work in the production of essences, whether of orange, lemon, mandarin, or bergamot, and concentrated lemon juice, the latter of which is carried on on a large scale. The lemon is the most productive and the most remunerative, and gives the largest returns per acre of land planted. The trees are set about five yards distant from each other, in rows, and equidistant. Stony or sandy soil is apparently the best suited, for the best groves are near the beds of torrents, or on the coast line from Messina to Acircale, as well as from Milazzo to Messina, and in the neighbourhood of Palermo. They will not thrive in a stiff soil, such as clay, for roots are superficial and abundant. The trees have to be well manured at least once a year, and the way is to dig a trench, say about 40 inches from the stem, and bury the manure 18 inches below. Ripe stable, mixed with wood ash and bone, is said to yield the best, and fetches the highest price. The blossoms of April produce the best fruit, known as "primofiore" or choice fruit, which is gathered in October, and those of May, yielding a second crop, gathered in November and December, are the best crops as well as the most abundant, and upon them proprietors base all their calculations. The blossoms of June produce fruit gathered in January and February; those of July generally fall off, and little heed is taken of them; those of August are gathered in March; those of September produce a better fruit, gathered in April and May. The fruits of those of October, November, and December are known as bastards, and are gathered in June, July, August, and September; whilst those of January, February, and March yield little fruit, which falls under the same denomination.

The first gathering takes place in October, and care is taken that the lemons are not less than three inches in circumference; all under this size are left for the November gathering. Practised hands gauge the fruit with thumb and second finger. The first crop (the most valuable) is carefully selected, packed and shipped off for early spring or summe use, and realises 30 per cent. more than any subsequent gathering. No time is therefore lost in sending it off as early as possible, in order to get th highest price. The cases are of various sizes, to sui the different markets; those for France are of on size, those for London another. Each case contain about 450 lemons. For the States and Trieste boxe are used containing only about 360. All that ar considered inferior are put in small cases for th Italian market, and fetch 40 per cent. less. Th second gathering takes place in November, and is a good as that of October, and will keep for months i boxes if properly selected and packed; it is paler i colour and harder to the touch. It is, therefore, ofte kept in cases until March, then unpacked, and keep good for a reasonable time. This chiefly goes to th States and Russia. All small or damaged fruit which must not be left on the tree, is collected an used for making essence from the peel, and concentrated juice from the pulp, The custom is t calculate 104 kilos. of this inferior fruit as equivale to 1,000 lemons, and charge 30 per cent. less tha for the good box fruits. Of all inferior fruit, tha gathered in November is considered the best for th making of essence and limejuice, because it contai more valuable properties, yielding 50 per cent. mo than that of other months; 1,000 of these give abo 16 ozs. of essence and 35 litres of raw lemon juic which, after concentration to its normal standard 64 ozs. of citric acid per imperial gallon, is reduce to $3\frac{1}{2}$ litres. On a well cultivated plantation resul show that seven-eighths of November fruit is go or shipment, and only one-eighth for essence and limejuice.

The fruit gathered in December is considered nferior, as only five-eighths are fit for exportation, ınd three-eighths go for making essence and limeuice. It is packed in small cases for the States, Southern Russia, and Trieste. It is worth about 5 per cent. less than the same sized cases of November fruit; also the per-centage of essence is about 15 ozs. less per 1,000, and the juice about 4 litres more. After the juice is expressed, the esidue is given to the goats. The January fruit, gain, is inferior to that of December, only three-ighths being fit for packing; the rest is used for uice and essence. This fruit is perfectly yellow; such as is fit for exportation is packed in boxes, the ame as that of December; that which is not is cut ınd pickled in casks with salt and then exported. Each cask contains about 3,400 lemons.

February's fruit is the last of the season; it is also alled the old fruit because of the remains of previous gatherings. Nothing is now left on the tree except he green fruit of the August blossom. Of this crop only two-eighths can be packed for shipment, which n arrival have to be sold at once, as they will not eep. The remainder are used for essence, juice, and ickling, and yield about 12 ozs. of essence and bout 42 litres of raw lemon juice. It costs about s. 4d. to extract the essence of 1,000 lemons, and 4 to make a cask of lemon juice, including fruit, ost of cask, and labour.

The so-called extraordinary crops depend upon the ıode of cultivation, and also climatic influences. rrigation also enters largely into bringing it about. f a tree be deprived of irrigation during the hot ıonths of July and August, and then abundantly vatered in September, a spurt is put on producing n extraordinary amount of blossom, which results in he valuable May crop. This cannot be done every ear, for the tree suffers from the privation alluded o, and subsequent fruit is retarded in its development, yet when the demand for May fruit is great nd prices range from 30s. to 40s. per 1,000 it is one, as these prices compensate for any loss in eptember and October. The March crop, known s "biancuzzi," and which is the result of the August lossoming, is the least valuable, for it will not stand long voyage. It is sent to Trieste in small cases, either does it yield essence nor juice. Prices average bout 40 per cent. less than those obtained from ood lemons.

The April yield from the September blossom is ot much better than that of March, yet some good uit may be picked out for packing, but nearly all is sed for local purposes. The May yield, which is so the yield of the September blossom, known as verdelli," is much sought after, and is shipped to the tates in small cases. The fruit is of excellent keep-g quality, and easily stand the voyage. No care is cessary in gathering or sorting the fruit, as it is all od, worth 25 per cent. more than winter-grown fruit. The so-called "bastardi" are gathered in June and July, and are the results of October and November blossoming. They are packed in similar cases, and are sent to London, Liverpool, Trieste, and the States. In August and September the lemon crop is smaller, and inferior to those of the previous months; it realises less on this account, and also because the lemon crop in South Spain begins.

The management of a lemon plantation demands attention. Trees should be trained high to admit free ventilation, pruning to take place regularly once a year, dead wood, unhealthy and redundant branches removed. In cases of a heavy crop the branches have to be supported. Trees have to be watered in summer, with a little liquid manure in the water, once a week, and the ground kept free from all undergrowth. Market gardening is occasionally practised between the trees, because the vegetables grown pay expenses for manure and cultivation, but it is not to be recommended, as the fruit suffers in consequence. The tree should always be grafted on the bitter orange; if grown from the pip it is subject to a disease called the gum, which often destroys it. Grafting takes place after three years, and is practised in the same way as on the rose tree. The tree requires an equal temperature. Lands bordering on the coast line are the most favourable, provided the situation be a sheltered one, as the trees are very susceptible to great variations of temperature; yet they cannot be reared on a coast exposed to the strong south-west wind, nor in localities subject to frost. The north-east winds are the most injurious, from which they must be protected by intervening trees. Precautions against frost are indispensable. A keen wind will often blight a whole crop; in this case it is absolutely necessary to clip and clear away all branches that have been frost-bitten. Under these conditions, more or less obtainable in Sicily, seed may be sown in April, two or three centines beneath the surface, but the ground thus sown must be surrounded with a border of mould and well watered. When the seedlings are large enough to be moved, they are transplanted into small holes prepared during the summer for that purpose. The ground round lemon trees requires to be hoed three times a year—in December, after the heavy autumnal rains; in April; and, lastly, in May, in order that they may be easily watered in summer. The clearing away of dried twigs and suckers precedes the pruning, and sometimes renders the latter unnecessary. A proper pruning will often enable the trees to resist the effect of a violent sirocco. The pickling of lemons for exportation is a very simple process. They are first cut in two and immersed in salt water for from three to eight days, they are then placed in casks with alternate layers of salt, salt water is then introduced to fill up spaces, and the cask is closed up ready for exportation.

With all this there is another industry in this connection, which, it is to be regretted, is lost sight of in Sicily, or, if practised, it is only on a very small scale, namely, that of collecting the petals of the blossoms, whether of orange or lemon, that fall off and cover the ground as soon as the fruit appears, for making orange flower water. In the matter of packing, it is stated that the whole cost of a large case does not exceed 1s. 8d., made up as follows:—Cost of case itself, 9d.; paper, 6d.; gathering and packing, 4d.; nails and hoops, 1d., so that the whole expenditure attending the gathering and packing of a case of oranges is very small.

Correspondence.

THE ETYMOLOGY AND MEANING OF "PLEACHED."

Referring to the discussion on the paper on "The Garden in Relation to the House," read by Mr. Inigo Thomas, at our meeting on the 4th, and published in last Friday's issue of the Society's *Journal*, no one has any right, derived from any proofs as yet produced, to say that Messrs. Blomfield and Thomas are in error when in their charming book, "The Formal Garden," they use the word "pleached" for "clipped."

I cannot find the use of the word anywhere older than by Shakespeare, who uses it thrice—"pleached alley," "pleached bower," and "pleach'd arms." The etymology of the word is, within certain limits, as ambiguous as its meaning is obscure. It is, indeed, traced back through the Latin *plecto* and *plico*, to the Greek πλέκω. But there are two Latin words, *plecto*, the first, meaning "I strike" (*cf.* *plectrum*), "cut off," "punish," the root of which is *plag*, as in *plāga*, "a blow," "a stroke," "a cut," and the second meaning "I braid," "intertwine," the root of which is *plec*, as in *plăga*, "a flat surface," (*cf.* French *plage*), "tract," "zone," "curtain," &c. This *plecto* is connected with *plico*, "I fold," "wind," "coil," "wreathe," whence the Italian *piegare*, "to wind awry," "to draw which way you desire," the Spanish *plegar*, "to fold" (whence *plego*, a sheet of paper, *i.e.*, "folio"), and the French *plier*, "to bend;" while "plico" itself goes directly back to the Greek πλέκω, "I plait," "wreathe," "make up with art," and πλεκτή, "a coil," "wreath," "basket," &c. The latter is the accepted line of the descent of the word "pleached," and it certainly lends itself, in connection with an alley or a bower, rather to the meaning "artificially arranged," *i.e.*, "clipped," than to "naturally tangled," or "wreathed with blossoms." In view also of the gardening style of the reign of Queen Elizabeth, the word, as used by Shakespeare, could hardly have had any other meaning than "clipped;" and it is difficult to give any other meaning to the word, from the context, as used in "Much Ado about Nothing." But it is frequent found that words have multiple etymologies, a Shakespeare's use of the word "pleached" "Antony and Cleopatra," seems to indicate its de vation from *plecto*, "I strike," "cut down," a *plāga*, "a cut," "stroke" and if this be so, the could no longer be any doubt of "pleached meaning "shorn," "stripped," "clipped," Messrs. Blomfield and Thomas have quite unassa ably taken it to mean.

As there is so much strong feeling on the absurd opposed subjects of imaginative landscape gardenin and formal gardening, let me say that, though lover of both styles, I am a partizan of neither. B this is another question; and I will only add, in co nection with it, that some years ago I found Beaudesert, the seat of the Marquess of Anglesea Staffordshire, an old formal garden as perfect in eve detail of its plan as when first laid out. On my w thither I passed through the original "Bota Garden" of Erasmus Darwin. It may have be laid out by Humphrey Repton—I know nothing that point—but although now run all to wilderne and cut up by farmhouses, and farm roads, it s strikingly shews how greatly our national style "English gardening" may be made to enhance t picturesqueness of the natural features of a lan scape,—as no formal garden can. It only sets the architecture of the house. The Elder Darwi garden, which has been altogether overlooked botanists, still contains many of the outland tr wherewith he stocked it, and the unusual appariti of them on some commanding spot at once transf the wayfarer to other and brighter climes.

George Birdwood.

8th February, 1896.

SUPPLY OF SEA WATER TO LONDON

With regard to the lecture on "The Supply Sea Water to London," delivered on 22nd ult., ma be allowed to demur to any increase of the vest interests in London, and this more especially as th is a plan evolving by which it is hoped that London County Council may be enabled to sup sea water to all the ornamental waters, baths, & and in fact practically to all London (with the exce tion of domestic purposes), and to indicate t sources from which the capital may be raised wit out any increase of the rates.

J. Oakeshott.

26, Mount-park-crescent, Ealing, W.
11th February, 1895.

General Notes.

South Kensington Museum.—Arrangeme are now complete for lighting in the evening t southern galleries of the South Kensington Muse n the west side of Exhibition-road, which contain ıe collections of machinery and naval models. hese galleries will be open free to the public from 7th February on three evenings a week—Mondays, uesdays, and Saturdays, till 10 p.m.—in the same ıanner as the main building.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock :—

February 19.—"Report of the Royal Commis-on on Secondary Education." By H. Macan. Sir wen Roberts, M.A., will preside.

February 26.—"The Standard of Musical Pitch." y A. J. Hipkins. Sir Alexander C. Mac-enzie, Mus.Doc., will preside.

March 4.—"Röntgen's Photography of the In-sible." By A. A. Campbell Swinton.

March 11.—"Peasant Life and Industries in Ire-nd." By Prof. A. C. Haddon.

Papers for evenings, the dates of which are ot yet fixed :—

"Bahamas Sisal Industry." By Dr. D. Morris, .M.G., M.A.

"Our Food Supply, as affected by the Farming of ıe Future." By Prof. James Long.

"Dairy Produce." By George Barham.

"Orthochromatic Photography." By Capt. W. e W. Abney, C.B., F.R.S.

"High Explosives and Smokeless Powders." By udson Maxim.

"Early English Organ Writers." By Burnham orner.

Indian Section.

The meetings of this Section will take place n the following Thursdays, at Half-past Four r Half-past Eight o'clock :—

February 27, at 4.30.—"The Tobacco Industry f India and the Far East." By C. Tripp, formerly f Sumatra. The Marquis of Lorne, K.T., M.P., ill preside.

March 19, at 8.30.—"The Great Landslip at ohna, in Gurhwal, and the Measures Adopted to revent Serious Loss of Life." By J. H. Glass, .I.E., Chief Engineer, Dept. Public Works, engal. Sir Charles H. T. Crosthwaite, .C.S.I., Member of the Council of India, and late ieutenant - Governor of the North - Western rovinces and Oudh, will preside.

March 26, at 8.30.—"Kashmir: its People and s Products." By Walter R. Lawrence, .C.S., C.I.E.

April 23, at 4.30.—"The Deserted City of ijianagar." By Captain Charles Rolleston.

May 14, at 4.30.—"Tea Planting in Darjeeling." y G. W. Christison.

The meetings of February 13, April 23, and May 14 will be held at the Society of Arts; those of February 27, March 19, and March 26 at the Imperial Institute.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

February 25.—"The Palette of the Potter." By William Burton, F.C.S. Walter Crane, R.I., will preside.

March 10.—"English Book Illustrations, 1860-70." By Joseph Pennell.

April 14.—

May 12.—"The Future of the Fine Art of Wood Engraving." By W. Biscombe Gardner.

Foreign and Colonial Section.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

February 18.—"The Development of Electrical Traction Apparatus." By H. F. Parshall (General Electric Company, U.S.A.). W. H. Preece, C.B., F.R.S., Vice-President of the Society, will preside.

March 3.—"The Commercial Prospects of English East Africa, and British Central Africa." By G. Scott Elliot. Sir James Crichton Browne will preside.

March 17.—"The Maories." By H. Vogel. Sir Westby Perceval, K.C.M.G., Member of the Council, will preside.

April 21. — "Madagascar." By Captain Pasfield Oliver. Major Marindin, C.M.G., will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

Prof. J. M. Thomson, F.R.S.E., "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c." Three Lectures.

February 17.—Lecture I.—Nature of the course—Metals to be dealt with—Certain physical properties relating to the selected metals—Some chemical properties relating to metals generally—Principles underlying the methods for the extraction of these metals—Formation and general properties of certain alloys of these metals.

February 24.—Lecture II.—Chemical relations of the selected metals to some non-metals and to each other—Compounds of iron—Oxides—Ferrous and ferric condition—Ferrous carbonate—Oxidation of ferrous compounds—Action of Acids—Copper compounds—Oxides and hydrates—Chlorides and oxychlorides—Acetate and carbonate—Changes produced on copper compounds—Superficial coating of green compounds on copper.

March 2.—Lecture III.—Zinc and tin compounds—Use of these metals as protective coverings for iron and copper—Behaviour of such coated plates with chemical reagents—Action of acids in tin—Lead compounds—Action of water upon lead—Formation of protective coatings—Metals and alloys used more particularly for decoration—Effect upon them if exposed to the atmosphere of towns, &c.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. M. Thompson, "The Chemistry of Certain Metals and Their Compounds used in Building, and the Changes Produced in Them by Air, Moisture, and Noxious Gases, &c."

East India Association, 3, Victoria-street, S.W., 3 p.m. Mr. Alfred Nundy, "The Indian National Congress: its Origin, Aims, and Objects."

Junior Engineers, Westminster Palace Hotel, S.W., 7½ p.m. Mr. H. M. Rounthwaite, "Marine Engineering Design." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 8 p.m, Mr. A. A. Hudson, "Conditions of Building Contracts."

Imperial Institute, South Kensington, S.W., 8½ p.m. Colonel J. Harris, "The New British Route to the Pacific."

Medical, 11, Chandos-street, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Phené Spiers, "Saint-Front of Perigueux."

Victoria Institute, 8 Adelphi-terrace, W.C., 4½ p.m. Dr. Gordon, "China."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Seymour Lucas, "Picture Painting."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Rev. F. C. Lambert, "The First Principles of Pictorial Composition."

Tuesday, Feb. 18 ... SOCIETY OF ARTS, John-street-Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. H. F. Parshall, "The Development of Electrical Traction Apparatus."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Covering of Plants and Animals: its Structure and Functions." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. A. E. Hunt's Paper, "The Manufacture of Aluminium by Electrolysis; and the Plant at Niagara for its Extraction."

Statistical, Royal United Service Institution, Whitehall, S.W., 5 p.m. Dr. Francis Warner, "Mental and Physical Conditions among 50,000 Children seen 1892-94, and the Methods of Studying Recorded Observations, with Special Reference to the Determination of the Causes of Mental Dulness and other Defects."

Photographic, 50, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Arthur G. Butler, "The Butterflies obtained in Arabia and Somaliland by Captain Charles G. Nurse and Colonel J. W. Yerbury in 1894-1895." 2. The Lord Walsingham and Mr. G. F. Hampson, "Moths collected at Aden and in Somaliland." 3. Miss Marion Newbigin, "Observations on the Metallic Colours of the *Trochilidæ* and the *Nectariniidæ*."

Wednesday, Feb. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. Macan, "Report of the Royal Commission on Secondary Education."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1895." 2. Mr. Robert H. Scott, "Notes on the Recent Unusually High Barometer Readings in the British Isles." 3. Mr. Richard Inwards, "Turner's Representations of Lightning."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. F. R. Dixon-Nuttall, "The Male of *Stephaneceros Eichhornii*." 2. Messrs. W. and G. S. West, "New Freshwater Algæ."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. G. F. Scott-Elliott, "Notes on Flower Haunting Diptera." 2. Mr. A. Radcliffe-Grote, "The Nomenclature of the Geometridæ."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Institute of Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. Mr. E. T. McCarthy, "Mining in the Wollastonite Ore-deposits of the Santa Fé Mine, State of Chiapas, Mexico."

Thursday, Feb. 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. E. J. Lowe, "Discoveries resulting from the Division of a Prothallus of a Variety of Scolopendrium Vulgare."

Chemical, Burlington-house, W., 8 p.m. Prof. Armstrong, (1) "Origin of Colour; the Yellow, 2; 3, Hydroxynapthoic Acid." (2) "Note on Etherification." (3) "The Relation of Pinene to Citrene."

London Institution, Finsbury-circus, E.C., 6 p.m. Captain Wiggins, "My Voyages to Siberia."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Marshall Ward, "Some Aspects of Modern Botany." (Lecture II.)

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Frederick H. Evans, "Lincoln Cathedral."

Historical, 20, Hanover-square, W., 5 p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Chapman Jones, "Density Measuring."

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. W. J. Brewer, "Light Railways."

Friday, Feb. 21... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. Edward Frankland, "The Past, Present, and Future Water Supply of London."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Geological, Burlington-house, W., 3 p.m. (Annual Meeting).

Saturday, Feb. 22...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Light." (Lecture I.)

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FRIDAY, FEBRUARY 21, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 17th inst., PROFESSOR J. M. THOMSON, F.R.S.E., delivered the first lecture of his course on "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c."

The lectures will be published in the *Journal* during the summer recess.

FOREIGN & COLONIAL SECTION.

Tuesday evening, February 18th; W. H. PREECE, C.B., F.R.S., Vice-President of the Society, in the chair.

The paper read was "The Development of Electrical Traction Apparatus," by H. F. Parshall, General Electric Company, U.S.A.

The paper will be printed in a future number of the *Journal.*

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 13, 1896; Lieut.-Gen. R. STRACHEY, R.E., C.S.I., F.R.S., in the chair.

The CHAIRMAN, in opening the proceedings, said the subject of irrigation in India had often been under the notice of the Society, and was one which readily lent itself to repeated discussion, especially as there were so many various points of view from which it might be regarded. First of all was the engineering aspect, the manner of obtaining the water supply and distributing it, and getting over physical difficulties, and so forth; then came the agricultural point of view or its application to husbandry, including questions as to how it could be best applied, under what circumstances, what quantity, and the like. Another branch of the subject would lead to questions of administration, as to how the distribution and management of the water should be undertaken. On this subject various views were held, some inclining to leave it in the hands of engineers, whilst others would restrict the duties of those gentlemen to the mechanical operations, and not charge them with duties, which might next be considered, viz., those arising from a fiscal point of view, as to how the water was to be charged for, and how the rates were to be collected. This last question involved a further one as to the tenure of the land to which the water was applied. The introduction of irrigation into any district necessarily altered the rental value of the land, and where there were tenants and a landlord the question arose in what proportion the tenants and landlord respectively should pay. If the landlord received an increased rent it was only reasonable he should pay for the advantage thus obtained. In dealing with irrigation in a country like India they again came across the fact of its enormous extent, of its varying physical features, the climate and habits of the people. It was evident, therefore, that the subject was almost unlimited in the breadth of ground it covered. Beyond all these questions there was another which experience had shown was of the greatest importance, and that was the question of the general financial arrangements under which the funds required for prosecuting irrigation works should be provided. He himself had participated in past years in maturing the arrangements under which the great irrigation works of India were now being carried out, and it had been a great satisfaction to him to see the results had been so eminently satisfactory. He might also say a word as to the nature of the obligation on the Government to supply the means of irrigation. No doubt irrigation led immediately to an important increase in the public revenue, but it was not merely from this aspect that it had to be considered. The construction of these works afforded very material means of preventing the calamity of famine, and from this point of view a great deal had been done to assist the development of irrigation, which, ever since the British Government undertook to carry out these works, had called for a very large expenditure of capital. In the paper about to be read reference was specifically made to one particular province—the Punjab—and with a view of assisting them to appreciate the figures to be put forward he would make a little comparison between the magnitude of that province, and the irrigation operations about to be explained, and Great Britain. Great Britain not including Ireland had a total area of about 78,000,000 acres, of which about 48,000,000 were under cultivation, and in 1883 the proportions were 10,000,000 acres to corn crops, 5,000,000 to green crops, including roots, and 35,000,000 to pasture. Now, in

India there was no pasture. There was a certain amount of land left for grazing, but it was not pasture. The Punjab was estimated, according to Sir William Hunter's "Gazetteer," to contain 64,000,000 acres, of which 24,000,000 were cultivated or ploughed, 6,000,000 maintained for grazing, 24,000,000 were uncultivated but cultivable—and this was an important element—and 20,000,000 were barren. The 10,000,000 acres in Great Britain which grew corn crops, were, in 1883, about equally divided between wheat, barley, and oats, though since that time wheat had probably diminished. Still, there were between 2,000,000 and 3,000,000 acres of wheat grown. In the Punjab there were between 7,000,000 and 8,000,000 acres of wheat, though the yield per acre was much less than in England. The land irrigated from the canals under Government control was about 5,000,000 acres; about double that area was estimated to be irrigated by wells. The value of the irrigated crop was reckoned at from 25 to 30 Rs. an acre, or from £1 10s. to £2; and the year's crops of the irrigated land was worth about £5,000,000 sterling. The crop of a single year was almost sufficient to pay for the entire cost of the whole irrigation works. In the North-West Provinces, in 1894, there were about 2,000,000 acres irrigated, and the value there was reckoned to be somewhat greater. The average charge for the use of water was between 7 and 10 per cent. of the value of the crop produced. Before calling upon Sir James Lyall to read his paper, he might briefly state what his qualifications were for dealing with this subject. His career had been mainly passed in the Punjab, where, from 1862 to 1879, he was a settlement officer, in which position his duties brought him into contact not only with the cultivators, but with the canal officers and all matters connected with the Irrigation Department. The settlement of the revenue, or the charge made to the cultivator by the Government for the occupation of the land, depended on its productive power, which, again, was largely determined by the facilities afforded for agriculture by irrigation, and it was the special duty of the settlement officer to make himself acquainted with all the particulars which related to the occupation of the land. Sir James Lyall eventually became Finance Commissioner, the officer who had general control of the whole revenue of the province. In these duties he was occupied for 20 years. He was then called upon to discharge very important functions in Mysore, where there was also a great system of irrigation, though not at all like that in the Punjab, to which province he again returned, in 1887, as Lieutenant-Governor, when he again had the opportunity of reviewing, from a different point of view, the whole of the questions which had come before him in these other capacities. He would now call upon Sir James Lyall to give the result of his long and varied experience.

The paper read was—

PUNJAB IRRIGATION: ANCIENT AND MODERN.

By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.

My subject includes all kinds of irrigation known in the Punjab, but at the present day irrigation canals are of course much the most important kind. I will begin, therefore, with a proposition about them, which I think ought to be generally recognised, and which I hope you will find to be established by the facts which I propose to place before you. This proposition is that irrigation canals are, first, much more generally necessary; second, much more of an unmixed benefit; third, more likely to be profitable to Government; and fourth, capable of much greater extension in the Punjab than in any other province of India. They are more necessary because of the very low average rainfall, and because the agricultural population increases with exceptional rapidity and demands more culturable land, which it cannot get in the Punjab without them. They are more of an unmixed benefit because most of the country, from light rainfall or deep water level or both, can be irrigated without getting water-logged which is seldom the case elsewhere. They are more likely to be profitable to Government, because in a dry country the demand is more constant, and the cultivator is able and willing to pay a higher price for water; also because the Punjab Government is the owner of huge areas of waste land which the people are willing to buy or rent at high rates if water can be brought on it. Lastly, they are capable of much greater extension from the natural configura- of the country, the greater part of which consists of a large level plain traversed and commanded by seven great rivers.

The map on the wall shows the whole province, and also takes in the north parts of Afghanistan and the territories of the Maharaja of Kashmir, and Chinese Thibet. I have included this foreign territory in the map to show the enormous reservoir or catchment basin from which the seven great rivers which debouch on the Punjab plain are fed. You will see that on the head of this great plain is seated a wide-spreading tract of mountainous country shaped like a cocked hat. The base of the hat measures some 700 miles on the map, from the sources of the Indus and Sutlej in Western Thibet to the sources of the Cabul river in the Hindu Kush behind Cabul. The great ranges of the Hindu Kush, Mustagh, and Kara-Koram mountains form the arch or rim of the hat. From rim to head of the plain the distance on the map is everywhere some 250 miles. This enormous mountain tract, two or three times larger than the Punjab plain, sends all its water down the seven rivers, and its winter snows and summer rains and the melting of the numerous glaciers combine to yield a supply exactly suitable in time to the climatic requirements of the plain.

The great heat begins in the plains in April and goes on increasing to the end of June, and in these three months no rain can be expected, but the rivers, in spite of absence of rain, run high in these months owing to the melting of the snows and the glaciers. July, August, and September are the months of the summer rains, but they are scanty and very broken in the plains except in the sub-montane parts, and generally cease about the middle of September, too early for the proper ploughing and sowing of the winter crop. But all this time and till the end of October, thanks to the rain and melting of snow and glaciers in the mountains, the rivers run very high.

The population of the province itself, as distinct from the foreign territory which I have mentioned, is marked in the map. Its total population, which is almost entirely agricultural, and was by the census of 1892 25,000,000, or 2,000,000 less than that of England. The contentment of this agricultural population is of the highest political importance, as from it the greater part of our Indian army is recruited, and it supplies soldiers and constables for service in Burma, and our colonies in the Straits, China, and Africa.

The total area of the province is in round numbers 150,000 square miles, or about three times the size of England. But one-third of this may be held to consist of mountainous and sub-mountainous country, and plains enclosed by hills, like the Peshawar and Bannu valleys, all which are out of reach of irrigation from the great rivers. Putting this one-third aside for the present, there remains about 100,000 square miles of open plain, every part of which—so far as levels go—is commandable by one of the great rivers. This plain slopes from north to south, the average elevation, clear of the hills at the top, being about 900 feet, and at the bottom, where it touches Sindh, under 250 feet; but it also slopes from both sides towards the centre, which is, in some parts, another fact favourable to irrigation. For instance, the Indus, a little below Kalabagh, and the Jumna at Karnal, are almost at the same elevation of, say, 800 feet; but Shapur, on the Jhelam, and Ferozepur, on the Sutlej, which are on a line between these two points, are each some 150 feet lower. Again, Karnal is 400 feet above Multan, and Delhi 450 feet above Mithankot. It seems an accident—perhaps an unfortunate one—that the Jumna did not flow, to join the Indus, by dry and dusty Hissar, and through the arid Bikanir desert, with its wells of depths of 200 to 300 feet, instead of turning east to join the Ganges, through a country with double the rainfall. There is a good slope the whole way, and no obstacle. The soil of this great plain of 100,000 square miles is generally a good loam, sometimes sandy, but hardly ever unculturable, if water is available. Not a rock or a stone is to be found in it, not even a pebble to throw at a dog. On the other hand, except close to the big rivers, you see no water on the surface: running streams or springs are unknown, except close to the hills; and but for the wells, a man might travel from one great river to another without finding water to drink.

I will now ask you to look at this smaller map, from which most of the mountainous country is excluded. It will show how wonderfully the plain country is marked off by the seven rivers and the Ghaggar into what may be called eight great natural irrigation divisions. These are the Delhi territory between the Jumna and the Ghaggar, the Cis Sutlej Sikh country between the Ghaggar and the Sutlej, the Jullundhar or Bist Doab between Sutlej and Bias, the Bari Doab between the Bias and Ravi, the Rechna Doab between the Ravi and Chenab, the Jetch Doab between the Chenab and Jhelum, the Sind Sagar Doab between the Jhelum and the Indus, and the Derajat between the Indus and the Afghan and Beluch hills. The last is not suitable for any very large irrigation work as the ground begins to rise rapidly a few miles west of the Indus, but on the other hand it gets some irrigation of a special kind from the hill torrents, as I shall mention later on. The others are all Doabs, that is tracts lying between two rivers, and commandable either from one or from both. I think I have said enough to prove the extraordinary suitability of the natural configuration of the country for irrigation works.

On the same small map you will see that the country is marked off into belts by scarlet lines. I have attempted to show by these belts the average rainfall of the plains. The facts which govern the rainfall are, first, that it decreases progressively as you get back from the outer range of the Himalayas; secondly, that it also decreases generally as you go from east to west. Inside a belt, therefore, it should be understood that the average rainfall approaches the higher figure shown in the belt towards the upper line and the eastern end, and the smaller figure in the opposite parts. The belts are of course arbitrary lines, but I have adopted them because the general system of cultivation, which I shall attempt to briefly describe, varies with the rainfall, and these variations fit in a broad way into these belts.

But before dealing with the rainfall of the plains I may as well describe the rainfall of the mountainous parts of the province which are outside this map. I can do this on the big map. A very high range covered with perpetual snow and having many glaciers runs from behind the sources of the Jumna to the Sutlej. Beyond the Sutlej it runs behind the sources of the Bias and Ravi to the Chenab. Beyond the Chenab its runs behind the Kashmir valley and the sources of the Jhelum to the famous peak of Nanga Parbat, on the Indus. Beyond the Indus it runs south of Gilgit, till it joins the Hindu Kush, on the Chitral border; we may call it the inner Himalayan range. The whole country behind this inner range lies at very high elevations, and resembles Thibet in aspect and climate. The annual rainfall is very small, and occurs mainly in the winter months in the form of snow. In Leh, for example, it is only 2½ inches; and though it is larger than this in places in low passes, irrigation is everywhere indispensable for cultivation of the only crop, which is grown in the short summer season. The Punjab territory beyond this range is insignificant. It consists of Kanawar, on the Sutlej, Spiti, and Lahoul. In Spiti I have seen crops of barley and peas being irrigated in fields 14,000 feet above sea level. Between this inner range and the first high range from the plains, generally known as the outer Himalayas, we have the small countries of Chamba, Kulu, and Bashar, belonging to the Punjab, and the valley of Kashmir with a rainfall of from 40 to 60 inches. Again, between the outer Himalayas and the Sewaliks, or other foot hills of the Himalayas, we have the Hazara district, the mountain part of Rawalpindi, Jammu, Kangra, and the Simla hill states. The rainfall of this tract varies from something over 35 inches, on the foot hills, to 100, or even 120, inches on the face of the outer Himalayas.

In the whole Himalayan country, between the foot hills and the inner Himalayas, the rainfall is ample, and irrigation is not necessary for any crop, except for fine rice, and is mainly used for that cultivation. The irrigation that exists is entirely from small channels drawn from mountain streams, not from the great rivers. It would be interesting to describe them, if time permitted, but it must suffice to say that they are mostly very old, and have been made and are maintained by the joint labour of the villagers. The area irrigated by them is in some parts very considerable. For example, in the British districts of Kangra and Hazara, for which we have statistics, the area returned is 211,000 acres.

I now come to the rainfall of the country outside the Himalayas, which includes the plains, and the tracts between the Salt range and the Afghan hills.

The first may be called the sub-montane and Delhi belt, and has a rainfall of from 25 to 35 inches. It starts from where the eastern boundary lines of the Peshwar and Hazara districts meet, and is very narrow in the Rawalpindi and Jhelum districts, but east of Jhelum it broadens out as shown in the smaller map. Irrigation is not necessary in this belt except for rice or for very high cultivation. Almost all crops can be successfully grown without it.

The second belt, with a rainfall of 18 to 25 inches, includes Peshawar and part of Kohat, and the greater part of Rawalpindi and Jhelum, besides the plains country from Lahore to Rohtak shown as included in the smaller map. In this belt irrigation of some kind may be said to be ordinarily necessary for all but crops of the simplest kind, and even they are precarious without it.

The third belt, which runs from Bannu across the centre of the plains to Hissar, has a rainfall of from 10 to 18 inches. In ordinary years some kind of irrigation is absolutely necessary here for the successful cultivation of any crop, except where there is a light sandy soil which retains moisture particularly well, as there is in parts of Bannu, and of the country to the east of the Sutlej; on such soil a light catch drop can be got from the simple rainfall only, if it comes at a seasonable time and to the average amount.

The fourth belt includes the Derajat, the

Multan country, and Bahawalpur, a very large area. It has a rainfall of 5 to 10 inches only. Here some kind of irrigation is indispensable to all cultivation.

My description of the rainfall shows that outside the Himalayas and the sub-montane and Delhi belt, or in other words in about three-fourths of the province, some kind of irrigation is more or less absolutely necessary. The only other tract in India which has a rainfall as inferior is that which lies between the Punjab and the Indian Ocean; it consists of the Sindh and Cutch divisions of Bombay, and the desert part of Rajputana. I think this proves that part of my proposition which asserts that irrigation works are more necessary in the Punjab than in any other province of India.

On this same small map I have attempted to show roughly the irrigation canals of kinds which were in working order in the plains when the province came under British rule. It did not all come at one time. We took the Delhi territory from the Mahrattas in 1803. Six years later the Cis-Sutlej Sikhs came under our protection. The rest of the province was annexed in 1846 and 1849, after the first and second Sikh wars. You will see that the inundation canals in the extreme south and the Hasli Canal in the north, were the only works of noticeable size in the plains. In the country between the Salt range and the Afghan hills, that is the districts of Peshawar, Kohat, and Bannu, there was some irrigation from channels taking off from rivers and streams issuing from the hills, but the proportion was very small. This being the case you will perhaps ask how the people lived in the three-fourths of the plains and the country behind the salt range, in which I have said irrigation of some kind is more or less absolutely necessary. The fact is that below the 18-inch rainfall line there was formerly hardly any cultivation in the plains between the Indus and Jumna, away from the river beds and the inundation canals. The scanty population which existed was either partly or entirely pastoral. There were huge tracts without villages or settled inhabitants. The tract from Hisar to near Fazilka for instance was, when we took it, almost entirely in this condition. It was colonised some fifty years ago by a set of hardy peasants, most of whom came from neighbouring native states. They were ready to bear great hardships for the sake of the safe title and light taxation they expected to get under our rule. The country was a sandy waterless desert. The first thing they had to do was to dig a pond in some hollow where a little water gathered when rain fell, and to sink a deep well more than a hundred feet deep beside it. The well water when reached was always salt at first, but under the influence of the pond it became gradually drinkable. Once established like this, they lived by the help of their flocks and herds, and of scanty catch crops grown on the light sandy soil in favourable years. Sometimes, for two or three years in succession, the showers failed, and the whole population temporarily emigrated, sending their flocks and herds to the nearest country where there was grass and water, and taking their wives and children where they could live by manual labour, till news of favourable rains having occurred brought them home again.

Again, all the central and lower parts of the Sindh Sagar, Jetch, Rechna, and Bari Doabs, a short distance away from the rivers, was formerly unsettled waste, and is still where no canals have come. The soil of these tracts, known as the Bar or Thul, approaches to clay, and has a smooth surface, which looks bare of grass except where a good shower of rain happens to have fallen. It is sprinkled over with a sparse growth of van, jhand, and karil, three shrubby trees or bushes which send their roots down a huge distance, and can live like the gazelle or the antelope with little or no water.

Part of the population of these Bar wastes was purely nomad, but most had some land in villages in the river beds, though they lived mainly by their herds and camels, buffaloes, and other cattle, and their flocks. They were a tall, strong set of people, though many of them scarcely ever eat bread or meat of any kind, milk and curds forming their ordinary diet. They had extraordinary loud voices, owing to the fine dry air of the Bars and their living in the open air. They shifted their flocks and herds from place to place at great distances, going where there was news of rain having fallen and grass sprouted. There were a few deep wells of brackish water here and there, from which the cattle were watered now and again.

Outside these unsettled wastes, used solely for pastoral purposes, there were several systems by which the people contrived to carry on cultivation in spite of the low and uncertain rainfall. The most important of these was irrigation by Persian wheels set in wells and turned by cattle. In the part of the plains where the rainfall is from 18 to about 28 inches, these irrigation wells are to be found in every village; in many, every plot of arable land is protected by its well, and the air is constantly full of the not unmusical drone of the revolving Persian wheel. In hot dry weather this goes on all night as well as in the day, till the rare good shower occurs, and the tired man and worn-out cattle have a temporary holiday. A shady tree or two, to shelter man and cattle from the burning sun of the summer, are planted over the well and its little yard, where the cattle are tethered. It may be said that to make cultivation by well irrigation fairly profitable by itself, not merely as an adjunct to other kinds of farming, well water must be aided at some seasons of the year by a moderate rainfall, or by water brought on to the land by flood or by canal. Another fact, restricting the extent of country in which well irrigation can be profitably carried on, is the depth below the surface of the springs and the quality of the water. In the first two rainfall belts of my map, and everywhere along the river beds, the spring level is near, generally from 15 to 40 feet. But the level begins to sink rapidly, to 50 and 100 feet or more, from the lower side of the second rainfall belt in the map, and the water, when found, is often salt; at spring levels of more than 50 feet depth, well cultivation disappears. In the extreme south, the water again comes near to the surface, but as the rainfall is here less than 10 inches, simple unaided well cultivation does not pay, though it is often carried on in a small way as an adjunct to cattle farming. The total area irrigated by wells is given in the Punjab Report for 1893-94 as 3,248,768 acres, and the number of irrigated wells in use at 243,337.

The next system is that of cultivation by the aid of river floods. The great rivers of the Punjab, after entering the plain, wind along in valleys, or rather depressions, from one to ten miles broad, and a few feet lower than the plains which separate them. When the rivers are at their fullest in the summer and autumn, they moisten the lands in their river beds, or part of them, by flood or percolation, and with the aid of this moistening crops can be grown, though if no winter rain comes it will be worth very little. In the parts of these river beds safest from the river action, wells are also commonly sunk to assist the river floods. The people in some parts assist the natural extenion of the floods by combining to open out the mouths of side-channels or back-waters of the rivers, and put temporary dams across them lower down.

The third system is that of inundation canals: these are great and long dykes or ditches dug from the bank of a river, generally from the bank of a back-water or side stream, and leading out of the river bed into the plains between the rivers. They are intended to draw water from the river when it is in flood, as the great rivers are from April to October, or thereabouts. To make this practicable, the level of the plains to be irrigated must be very little above that of the river bed, which is generally the case in the extreme south, and sometimes elsewhere. To make high cultivation possible from these canals they must be aided by wells, to be used when the canal runs dry in the winter, or when it unexpectedly fails in the summer, as often occurs, from damage to the head by river action: without such wells they can only grow a summer crop of coarser kinds.

The fourth system, locally known as "Rod kohi," or "mountain torrent" cultivation, prevails in the sloping plains of the Derajat along the edge of the Beluch and Afghan hills: also in the similar slopes along the lower side of the salt range. On the rare occasions when storms of rain fall in these hills, the usually dry ravines send torrents of muddy water down the nullas which lead across the plains. The people have covered the country round these nullas with a network of large fields, each surrounded by high earth embankments, but with an opening to let water in on the upper side. They unite to dam up the beds of the nullas at various points and so tilt the flood water out on the sloping plains, and with rough skill manage to get it into all or most of the fields, which then form ponds, shallow at the upper end and deep at the lower. When the water has sunk into the ground, the muddy bottom is ploughed and sown, and a crop results, even if no rain comes; but, in that case, the upper end of the field is generally a failure. Both summer and winter crops are grown in these fields, if storms in the hills occur in time for sowing, but often no good storms occur for a year or two, and if too heavy a storm occurs, the dams in the beds of the nullas are often broken down, and the water all runs away to waste. When this flooding operation is going on, the country is almost impassable on foot or horseback. Everywhere you are knee-deep or deeper in mud and water, except on the high banks of the fields, and these often show big gaps. So much mud is deposited by the water, that the level of the field rises greatly, and the sites of the villages sink into hollows. I see, from Doughty's "Travels in Arabia," that the same system of cultivation prevails in parts of that arid country. At the tail of the Ghaggar river a similar system prevails, which is, however, more like the basin system of irrigation on some of the Neli canals.

There are also some other systems by which the deficiency of the rainfall is redressed, by adding the rain water drained off other lands. For example, in the dry ravines of the hilly country behind the salt range, terraced fields are made with great labour in the ravines, and the flood water of the sides of the ravine is caught on these fields. In this way, a crop is secured, even in years when fields not so assisted fail.

Again, in the open plains, where the rainfall s from 10 to 18 inches, and the soil-clay hard nough for rain water to run on it, you often ind fields made across the imperceptible lope, each field being connected by little idges with its particular share of a broad strip f waste above. On these fields a poor harvest s secured occasionally.

By these various systems of irrigation—if all an be so called—and by their flocks and erds, a scanty population contrived to exist, ven in the dryest parts of the Punjab.

On another map I have attempted to show he present condition of canal irrigation in the lains, in contrast to its condition before our dministration began. You will also see indiated on it by red dotted lines the outlines of hree important canal projects, all of which ill, I have no doubt, be carried out in some hape, or at least commenced, at some time ithin the next fifty years.

I propose with the help of this map and the rge one to give you a very brief account of ach great canal, or system of canals, or great anal project in the province, beginning with e perennial, and ending with the inundation, anals.

But it will simplify what I shall have to say I first give a very general description of what great irrigation canal is like, how it is orked, and how it pays its way, for the benefit those who have never seen one or studied the bject.

A great irrigation canal is very like a river versed. If you have ever looked at a sketch ap of a river basin you will have seen that the tlines of the river and its tributary streams and rivulets make up a figure much like a wide-spreading tree. In the Punjab plains an irrigation canal, with its branches and major and minor distributory channels, has, on a map of its commandable area, much the same figure. But the tree top of course points up the slope of the country in the river map, and down it in the canal map. Again, while the river channels follow strictly in every part of the basin the lowest depressions they can find, the canal channels run along the highest ridges they can be kept to. Nature has shaped the river channels so as to collect and carry away the water of every part of the basin. The engineer shapes the canal to bring in and distribute water to every part of the commandable area, and so reverses nature's design.

There are two classes of irrigation canals in the Punjab—perennial and inundation. The first are designed to carry water throughout the year: the second profess to carry it only when the river which feeds them is in flood. The great perennial canals have regulating bridges across their heads which admit or shut out water by numerous sluice openings guarded by iron gates. Almost all these canals also require huge masonry weirs across the rivers below their heads to hold up the water when the rivers are low and force it through the regulator into the canal. The masonry weir is supplemented by a screen which runs along it, composed of a massive frame-work supporting hinged or movable shutters, which can be closed to hold up the water or let down to let it through. Under sluices have to be built through the masonry weirs to keep the channel above the weir scoured out by the current. To keep the weir from being undermined in front or from behind, the channel often has to be piled or pitched with big blocks of stone, or curtain walls have to be sunk to great depths. To prevent the river moving away and out flanking the weir long embankments have to be constructed to train the current to keep to its old channel. Only those who have seen these great rivers in flood can appreciate the skill required to construct head-works strong enough to control them. And their maintenance against the incessant attacks of the river is a long exercise of watchfulness, ingenuity, and pertinacity.

Again, where the canal takes out near the hills its line is often crossed by torrents from the hills finding their way to the river; these flow with great force and volume after storms. The canal has to be passed over these torrents by an aqueduct, or under them by a superpassage bridge, and then you have the curious spectacle of what resembles one great river flowing under another.

Escape channels also have to be constructed for these canals down which large volumes of water can be diverted to the rivers, if too great a supply enters the head, or if the demand for irrigation falls off unexpectedly, or a breach occurs in the banks. I may mention here that telegraphic communication has lately been established along these canals, which is most valuable when prompt action at the head or lower down is necessary. It prevents many accidents, and enables water to be sent quickly where it is most wanted at the moment.

When the canal gets well into the plain, it flows smoothly along like a majestic river, between broad grassy banks rather higher than the level of the country, which are planted with continuous groves of trees. A good road runs along the top of each bank, and at intervals, handsome masonry bridges of several arches span the stream. Near the bridges are often flights of steps leading down to the water, for the convenience of bathers, and here and there in the intervals of the bridges are ferry boats for the convenience of passengers.

The magnitude of these canals may be realised by saying that the large ones carry at full flow from three to four times the ordinary amount of water in the Thames above London, and carry their water to distances of 150 to 225 miles.

It has happened to me more than once to suddenly come upon one of these newly-made canals when riding on the march across the plains. I had known the country before as a monotonous, waterless expanse, treeless or, at best, only sprinkled with scrubby bushes. What a startling and pleasant surprise it was to now see a fine river rolling down, with lines of young trees, already springing up, along the banks.

After flowing some distance as one stream, the canal divides into branches, and from them what are called major and minor distributaries take off. The distinction between major and minor is not a definite one, but in the modern canals, the idea is that the major distributary or Rajbuha should be the main channel of supply for a considerable number of villages, and should send out to the boundary of every village a separate minor carrying that village's supply. It is part of the same plan that the Rajbuha should run constantly, and each minor only half-time, half the minors on a Rajbuha being closed, or "tatilled" as the phrase goes, against the other half.

From the end of the minor the landholders of the village construct one or more private water-courses which take the water actually to the fields.

The present scientific distributary system, which I have briefly described, is a vast improvement on the old system with which w began in Northern India. Then the engineers following old native precedent, only made th main canal channels, but after further experience they added a Rajbuha runnin parallel with and close to the main channel on either side.

From these the villagers were left to construct their private water-courses, long or shor according to the distance of the villages These water-courses were often badly made an aligned, leading to waste of water by leakag and to interference with the natural drainag of the country. Moreover, the men of the mor distant villages had to get the consent of inte vening villages to take water-courses throug their lands, and were often deterred by th difficulty, or had to submit to onerous co ditions. Again, as between the men of o village some applied for water before others ha made up their minds to use it, and when th latter subsequently wanted it, they had eith to make a separate water-course when o would have done for the whole village, or get a share in the old one on such terms as i owners might demand. The facts that certa irrigators had to make and maintain ve long water-courses, and that others got wat through other people's water-courses on one ous terms, tended to keep the water-rat unduly low, for it was necessary to have u form rates and these people could hardly affo to pay full rates.

There were other evils arising from this o system, among which may be enumerated waste of land and labour on unnecessary wat courses and loss of water by absorption them. The growth of complicated rights water-courses, leading to perpetual quarr and disputes.

The weakening of the banks of the can by the too numerous water-course heads them.

The necessity of "tatilling," or closing turn a host of private water-courses, in or to fairly distribute the available water when t demand was greater than the supply in t canal. This was a difficult and sometimes i possible operation, and the native subordina were corrupted by the power it threw into their hands. Now all the necessary "tatil" is done easily, and without confusion at the heads of the minors.

The slowness with which irrigation extended after a canal was opened, which greatly deferred the time when the canal could pay its working expenses and interest on capital cost. Now when Government conveys water by majors and minors to the boundary of every village, irrigation spreads with much greater rapidity.

I hope I have given to those of you who had no knowledge some clear idea of what a great irrigation canal is in India, and how it is worked, I have to now explain how the canals pay their way. Acreage water-rates are levied on all crops grown with the help of canal water, if the crops do not dry up from failure of supply. These water-rates vary with the crops in rough proportion to the amount of water each crop ordinarily requires. The receipts from these water-rates, with some other miscellaneous items, form what are called the "direct returns" of a canal. Among the miscellaneous items are navigation dues, when the canal is navigable, rent of water-power supplied to mills, sale of wood and grass from canal plantations, and sale of water for village tanks and ponds. The "indirect return" consists of a credit in account to the canal of the increase of land revenue due to its operation. It must be understood that in the Punjab and elsewhere in India, the land revenue is assessed from time to time upon the basis of a share of the existing rentable value of the estates, and this value is found to be increased when canal water is available.

Strict accounts are of course kept of all items of expenditure, direct or indirect, in the construction of a canal. These form what is called the "capital outlay." Account is also kept of interest due on direct capital outlay. All these items, when construction is completed, form what is called the "capital cost" of the canal. Similar accounts are kept, when a canal begins to work, of the cost of management and repairs, which form what is called the "working expenses." The gross revenue, less working expenses, is called "net revenue." Net revenue in excess of interest due up to date is called "surplus revenue."

In canal schemes there is a division into productive works and protective works. For a scheme to rank as a productive work, there must be a probability that at the end of ten years from time of opening the canal will be paying its "working expenses," and also 4 per cent. interest on its capital cost.

Canals of the productive works classes are ordinarily constructed with money specially borrowed for making productive canals and railways by the Government of India. For some time past India's borrowing under this head has been limited by the Secretary of State's order to 400 lakhs per annum. Moreover the amount is limited in so far as borrowing in England is concerned, by the fact that the Secretary of State has from time to time to get general sanction of Parliament. Having got that sanction up to a certain amount, say £10,000,000 sterling, he gradually uses it up, and then applies again. Protective canals are made by the Government of India from surplus revenue, which term includes the so-called Famine Fund.

I am afraid that all this general description must have been wearisome, particularly to those to whom there is nothing new in it, I will now pass on to the short account I promised to give of each canal and system of canals.

The first we come to on the map is the Western Jumna Canal.

This canal is an old work, first constructed by the Emperor Feroze Shah Tuglah, in A.D. 1351, to take water down to a hunting palace which he had built in the desert, at the place where the town of Hissar now stands.

Some 200 years later, this canal to Hissar was restored by the Mogul Emperor Akbar, and in 1626 his grandson, Shahjehan, added two branches, of which one was to carry water to his new palace and city of Delhi.

The Hissar channel never did much for the country generally, but these two branches seem to have given extensive irrigation in the 17th century. By the beginning of the 18th, however, the Sikhs had appropriated the water in the Hissar branch, and that town became deserted; and by 1750 the whole canal ceased to run, being neglected in the wars and revolutions of the period.

Soon after we took Delhi from the Mahrattas, in 1803, projects for re-opening the canal were considered, and work began in 1817. A remarkable number of men, who afterwards rose to great distinction, were connected with the work. Among them I may mention Henry Durand and Yule, and later on our chairman, General Strachey.

We began by simply re-opening the old native canal in its original form, which may be described as follows:—By temporary dams the water of a branch of the Jumna, near to its issue from the hills, was diverted into an old river channel which ran along the western edge of the Khadir, or river valley, to Karnal. Thence it was carried by a cut into one of the nullahs, or drainage lines, of the country above the Khadir, and so onward, by cuts or natural depressions, to its destination. In the same way the villagers simply re-opened their old disused water-courses, when we restored the main channels. The canal revenue began to exceed working expenses in 1833-34, and soon after a large surplus revenue began to accumulate, as the capital cost had been small. But neither the supply or the distribution were under proper control, and the canal channels and the water-courses crossed and stopped up the natural drainage lines of the country, causing water logging and great unhealthiness. Moreover, as the direct water-rate was light, and the indirect fixed land revenue assessment heavy, the people had no inducement to be thrifty in the use of the water. Remodelling schemes were therefore proposed and sanctioned to remedy these evils, and also to extend and improve the navigation channels of the canal. This work began in 1873, and has recently been completed at a cost of about 1,100,000 Rs. The works constructed are a permanent weir and a regulator at the head, which have given complete control of the supply. A navigable channel, with locks from Indri to Delhi, and thence to the Agra Canal at Okla, which is a financial failure, as the traffic is trifling. A new and extended distributory system of Rajbuhas and minors, and a large system of drains to relieve the water-logged country. These last two sets of works have immensely improved the sanitary condition of the formerly water-logged tracts ; but as this part of the country has a rainfall of 30 inches and a very small slope, I fear that canal irrigation is not even now a blessing to it. Luckily, the people have begun to take much less canal water except in years of drought. In ordinary years, with their rainfall, they can do without it, and they have been much influenced thereto by a change in the revenue system which relieves them of all charge direct and indirect when they do not irrigate in any season, and makes it much heavier, particularly on the rice crop, when they do.

The remodelling of the canal, and the falling off of the demand in the old irrigated tracts, have paved the way for great extensions of the canal into the dry tracts of the south and west. The greatest extension is the new Sirsa branch, which has just been completed at a cost of about 40 lakhs. Part of the money was found by the Patiala State, which, in return, is entitled to a share of the water. These extensions will not only enrich and protect against famine the dry country they enter, but will also make the demand on the whole Western Jumna Canal system always equal to or greater than the supply. With such a demand and high water-rates economy of water has to be studied by both canal officers and landholders, which is good for sanitation, and to prevent exhaustion of the soil.

The area irrigated by the old canal has varied greatly with the rainfall in recent years ; from 500,000 acres to less than half that figure. In 1894-95 it was in round numbers 350,000, of which 100,000 was due to recent extensions. In the same year the length of completed canal channel was 404 miles, and of distributaries 1,690 miles. In spite of the great cost of remodelling and extensions the canal paid in 1894–95 near 5½ per cent. on capital cost. When the new extensions come into full work this rate will, it is expected, rise to 7 or 8 per cent.

You will see marked on the map another canal taking off from the Jumna just below Delhi. This is the Agra Canal; as it is managed by the Government of the North Western Provinces, I shall say no more about it except that it has done some harm in the way of water-loggings to the small area it affects in the Punjab. It is another proof, therefore, o the difficulty of preventing this in tracts having in some years a high rainfall.

For a reason you will understand I will now skip over some intervening country and take you to the fine perennial canal known as the Bari Doab. This was a pioneer work begun in 1849 immediately after the annexation o the Punjab, when the re-opening of the Western Jumna was the only experience our officers had. Lieutenant Dyas, who had worked on tha canal, framed the plans and estimates under Colonel Napier, afterwards Lord Napier of Magdala. The practicability of building permanen weirs across great and turbulent rivers was no then established, and it was thought that b putting the head of the canal in the gorg where the river debouched from the hills a we would not be wanted. So the head was put a Madhopur, 1,100 feet above the sea, and th canal, for the first 12 miles, had to be take down a quick slope by a succession of fal and rapids, and through a country which ha too much water in it already. This mistake has imposed a heavy burden on the canal finances, but has given us a most enchanting piece of canal scenery. You ride up in the spring along grassy roads with fine trees in fresh green leaf above, and around fields yellow with the ripe wheat and barley. In front you have the long vista of the canal with its succession of falls and rapids, and behind that stand the wooded hills topped by the snowy peaks of the Himalayas. The canal was opened in 1860 before any system even of Rajbuhas or major distributaries had been completed. Most of the evils followed which I have described as attendant on badly aligned Rajbuhas, absence of minors, and long and numerous private water-courses. A weir had to be made after all between 1869 and 1875 at great cost and difficulty, owing to the terrific force of the current due to steep slope of the river bed. Later on the old Rajbuhas and water-courses were gradually remodelled into a distributary system of the modern scientific kind. The atter work required much tact in dealing with vested rights. For this work and many ther measures extending the usefulness and apacity of the canal, the chief credit has ately been given by Government to Colonel Ottley, long in charge as superintending ngineer, and now Inspector-General of Irri- ation in India.

The gross area commanded by this canal is ,479,935 acres, of which the average area ctually irrigated may be put at 537,150 acres r 36·29 per cent. Owing to the mistakes nade at the commencement the net revenue nly overtook the interest charges in 1888-89, r 28 years after opening of the canal.

The capital outlay to end of 1894-95 has been 75,82,976 rupees, and the net revenue for the ıme year gave, on a capital outlay, a return 9½ per cent., and is likely to give one of 10 12 per cent. in the future. The accumulated ırplus revenue has now reached the large sum 48½ laks of rupees.

It ought to be mentioned that in late years e policy has been adopted on this canal of adually withholding irrigation from the per tracts having a rainfall of over 25 ches, and passing all the water down to the ier tracts below. This is one great explana- n of the remarkable steadiness of the demand this canal; the measure is also justified by e fact that experience showed that in the per tracts the combined effect of canal irri- tion and a year of heavy rainfall was water- gging destructive to the health of the country.

The change effected in the drier tracts, such as the centre of the Doab level with Lahore and lower, is wonderful. This country, when I knew it before, was Bár waste, with here and there big cattle-owning and cattle-thieving villages. Every now and then they had good crops, principally of gram and barley. They were the sturdiest and biggest peasantry in India, the famous Sikhs of the Manjha, but rough in dress and not rich. Now, thanks to the large areas of their villages and canal water, they have become in the language of envious neighbours, "Jagirdars" or State pensioners. In the broad expanse of cultivation the very few trees now left of the kind peculiar to the thirsty Bar look shabby and forlorn, like a poor rustic in a smart city.

I will take you next to the Sirhind Canal. This great project was complicated by the fact that of the area commandable, which is put at 8,477 square miles, about half belongs to native States under the Punjab Government. In 1865 the Government of India in a liberal spirit decided that the right principle was to make no distinction, and adopt a scheme equally good for all. The consequence is that all native States having land in the commandable area can obtain water at ordinary rates.

The three Phulkian Sikh States have also been admitted to be shareholders in the canal, and are entitled to 36 per cent. of the water in return for having contributed 36 per cent. of the capital cost. They have their own branch and distributaries, from which they sell water to all lands commanded thereby, whether British or native State; our Government sells water to all on the same principle from its own branches. Colonel Robert Home and Colonel Gulliver, of the Royal Bengal Engineers, made the various plans and estimates, the first of which was sanctioned in 1870, and Colonel Home was the principal officer in charge of the construction. The canal was opened by Lord Ripon in 1882, but was not fully completed till 1891. The capital outlay up to end of 1894-95 has been Rs. 24,043,799 Imperial, and Rs. 13,896,193 from contributory States. Total, Rs. 37,939,992. The weir below the head is 2,370 feet in length. There are 541 miles of main channel, of which 190 are navigable and 4,384 miles of distributary. The provision from commencement of a really good distributary system is a distinguishing feature in the construction of this canal. It is calculated that the canal could if necessary irrigate as much as 1,200,000 acres.

These figures will give some idea of the size of the works. The financial prospects are somewhat uncertain. From 1883-84 till 1891-92 the irrigated area increased with rapidity beyond expectation, but in the three years ending 1894-95 the demand has only been up to half the power of the canal, and the area irrigated has greatly fallen off, for no reason that can be seen except that the rainfall has been unusually heavy. The area irrigated from British and native branches in 1894-95 was only 392,051, whereas it was over 900,000 in 1891-92. The explanation seems to be that the soil is a light sandy loam, which can grow fair crops with very little rain, and the canal water rates are not light; the people, therefore, only take canal water for a few fields, in years when they can grow the simpler crops without irrigation. The British branches only paid 1·53 per cent. on capital outlay in 1894-95 against no less than 7·27 per cent. in 1892-93, and the net revenue failed to meet the interest charges of the year by Rs. 5,44,863. Even now, however, it is confidently anticipated that the outstanding interest charges will be worked off in the next 9 or 10 years, and that the British branches will then pay an interest of 5½ per cent. The native State branches are not likely to pay so much, as the area they command is more to the east, and has a considerably better rainfall.

Out of respect for your time I must make my accounts of the other canals very brief.

If you look at the Peshawar district in the large map you will see the Swat River Canal shown as taking off from the point where the river emerges from the hills which bound the valley to the north.

It was made to bring under cultivation and populate part of the thorny waterless plain, which slopes down from the Afghan hills, and is cut at intervals by the deep dry channels through which the hill torrents after storms in the hills drain towards the Indus. The owners of the tract were a sturdy warlike tribe of Pathans, and it was infested by robbers from the hills.

The average rain-fall here is only 14 inches, and often fails to come at the season required. The canal turns from the river and runs across all the drainages of the country, being first carried under them by super-passages, and afterwards over by numerous aqueducts, culverts and syphons. It has a regulator at the head, but no weir was required as the river has a rocky bed, and carries little or no silt. It was made as a protective work out of famine fund revenue, at a capital outlay of Rs. 36,63,000, and was opened in 1885. It commands at present 120,000 acres of culturable land, and could irrigate annually at least 100,000, a dangerous proportion, so an extension by aqueduct is about to be made, which will add 10,000 acres to the commanded area.

In 1894-95 the net revenue gave 5 per cent. on capital outlay, and as the water-rates have been increased the return must now be 7 per cent. and all arrears of interest will before long be paid off. It has turned the tract into a sheet of cultivation dotted with villages, many of which are peaceably inhabited by the men who used to come down as robbers from the hills.

I will now pass to the Sidhnai Canal, which takes off from a singular straight stretch of the Ravi a little above its junction with the Chenab. In the dreary barren country which surrounds it this canal-like stretch of a usuall tortuous river, with banks thickly grown wit tall date palms, is a beautiful object. Th local tradition personifies the river as a god and says he straightened himself out suddenl to look the longer at a beautiful lady who wa bathing one day in his waters.

The Ravi runs dry much above this point i the winter half of the year, as the Bari Doa Canal now takes in the whole winter supply c the river at Madhopur. The Sidhnai, therefore, is classed as an inundation canal, thoug it has a permanent weir across the river an a regulator head.

The supply for the summer harvest is alway good, and nearly always sufficient for sowin the winter crop, but for its further growth tha crop generally has to depend on irrigation b wells, and the chance of some rain, which not much as the average annual rainfall only 5 inches.

The area commanded is 350,000 acres, which 206,000 were waste lands belonging Government; the balance which belonged villages was also waste, with here and the a few acres of cultivation round a well. T bring the Crown waste into cultivation th novel experiment of inducing settlers emigrate from over-populated districts in th north was attempted. The late much lament Colonel Wace, Financial Commissioner of th Punjab, framed an excellent colonisati scheme, which was carried out by Colon Hutchinson, the Deputy Commissioner Multan, in correspondence with the Depu Commissioners of the districts from which t emigrants came. The distributary channe (majors and minors) were first scientifical aligned along the ridges, and then t boundaries of the new villages, and of the interior holdings to be assigned to each individual settler, were framed to the shape in which they could be most conveniently and economically served by the distributaries. The fields were in a sense brought to the water instead of the water to the fields. The Sikh and Mahommedan peasantry of the Punjab showed their hardy enterprise, and all the holdings, which were about 90 acres each, were quickly taken up by men of a good class, able to bring ploughs and bullocks and some little capital.

The canal has proved the most successful irrigation work ever carried out by the Government of India. It was opened in 1886, by which time the colonists were mostly on the land. The return of net revenue on capital outlay has varied latterly from 10 to 19 per cent. It will certainly end by being 15 per cent. on the ultimate capital cost of the canal, which will not exceed Rs. 12,00,000. The value of crops raised in the years 1892-3 was about three times the capital cost of the canal at that date. The accumulated surplus revenue of the canal in 1894-95 was Rs. 7,108,599, and will before long recoup the whole capital cost.

I now pass to the Chenab Canal. You will observe that the mistake of putting the head near the hills has been avoided, and that the water will all go to a tract which urgently requires irrigation, and is not likely to be waterlogged by it in any part. For its average rainfall must be under 14 inches, and the spring level at present is never below 40 feet, and averages over 70. The original project was for a large inundation canal, but this, when opened, proved a failure. Schemes for a perennial canal of extended scope were submitted in 1889 and 1891, in the preparation of which Colonel Ottley, R.E., took the chief part. A long weir was then quickly and successfully built across the river; it is a vast mass of masonry and piled stone lying on the river bed, and having no depth in foundation. t is supported by long training-work embankments, as the river is notorious for shifting its channel. By the latest estimate of 1894 the gross area commanded is put at 4,731 square miles, of which about 3,000 are Crown waste. Of this huge area, however, part has to be set side as reserve for forest and pasture, and a mall part is unculturable. There remain somehing over 3,000 square miles, or 1,920,000 cres to be devoted to cultivation, of which it s estimated that from 1,100,000 to 1,320,000 ill ultimately be irrigated annually by the canal. Before the canal was opened the area commanded was almost entirely waste; it was only in the upper part that there was a sprinkling of well cultivation.

The rest was a grazing ground for the herds of the people living along the river heads, and of a few pastoral nomads. A scheme for simultaneously colonising the Crown waste was, of course, a necessary part of this great canal project. It was prepared by the late Colonel Wace in consultation with myself, and is being very successfully carried out. The area selected to be first granted to colonists, some 400,000 acres, was marked out and mapped out in squares of 27·7 acres, and was then divided into village estates of an area of about 2,500 acres, so placed as to be conveniently able to draw their canal water from one water-course. It was settled that of the 400,000 acres, 5 per cent. would be reserved for forest; 25 per cent. would be sold by auction to capitalists in lots not exceeding 550 acres; 15 per cent. granted on certain terms to agriculturists of the yeoman class, in lots not exceeding 140 acres; and 55 per cent. to peasants, in lots not exceeding 59 acres. But in the peasant villages, one-fifth of the area was to be reserved from allotment as common pasturage ground. Each grant was to be of so many particular squares or halves of squares, so as to make the grant always readily identifiable and prevent boundary disputes.

The peasants are to hold as Crown tenants without rights of transfer. This is an experiment with the object of preventing their lands from passing by sale or mortgage to money-lending capitalists.

In the present winter, another 400,000 acres of Crown waste is being allotted to settlers on the same general plan on a new branch of the canal. We might have realised a very large sum for Government by selling a much larger share of the Crown waste to capitalists, but this was sacrificed with the object of establishing an independent peasantry instead of a tenantry likely to be eventually rack-rented by a landlord class.

It was estimated, in 1891, that the total cost of the canal construction will be Rs. 2,65,15,966; that the works will be finally completed in the year 1900; that the net revenue will cover interest charges on capital outlay in 1902, and pay about 12 per cent. interest on capital outlay in 1909, and about 16 per cent. in 1915.

There is no reason to doubt that this forecast will be realised, as the report for

1894-95 shows that the area irrigated that year was nearly 100,000 acres, and the revenue Rs. 4,28,750 in excess of the forecast of 1891.

I ought to add that the colonisation scheme is carried out by a special officer of the Civil Service, in communication with the district officers of the over-populated districts in the north, who have all co-operated with much energy and interest. Yeomen and peasants of the best agricultural tribes have come forward in abundance, many selling their hereditary shares in their old village estates, become too small by subdivision for their substance, in order to emigrate. Capitalists have also competed eagerly for the land allotted to their class, and have paid a high price at auction for it.

I now come to the true inundation canals, by which I mean those which, unlike the Sidhnai, have no weir or head regulator. For want of time I must restrict myself to a brief general account of them. From the first of the two smaller maps you will see that before annexation a good number were at work, as I have already said, in the Multan, Muzaffargarh, and Dera Ghazi Khan districts, and one, the Khanwah on the Upper Sutlej, in Lahore and Montgomery. There were also some at work in the Bahawalpur State. The second map shows that the areas irrigated by inundation canals in these districts has greatly increased, and that they now exist also in the Shappur and Ferozepur districts.

I will deal first with those which are managed by the canal officers. They may be described under five headings, as follows :—

The Upper Sutlej canals: These comprise the old Khanwah and two other old canals reopened and extended by us, and an entirely new canal called the Lower Sohag and Para.

The Khanwah irrigated about 20,000 acres before annexation. With the other two it irrigated 196,325 acres in 1894-95.

The Lower Sohag and Para was devised to irrigate a very barren tract in which Government owned a very large proportion of the land. It was completed in 1887. By a colonisation scheme similar to that or the Sidhnai Canal, 50 new villages of colonists have been established on 78,000 acres of Crown waste. In these, and in adjacent old villages, the canal irrigated 70,000 acres in 1894-95. Accounts of interest on capital cost are kept for this canal, and it is estimated that all interest due will be paid up by 1898. The net revenue in 1894-95 gave a return of 4·47 per cent. on capital outlay.

The Lower Sutlej and Chenab Canals come next. They are all in the Multan district. There are 34 separate channels at annexation; many of them have been amalgamated, and they are now reckoned as 16 canals with branches. In 1864-65, the first year for which I have statistics, their irrigated area was returned at 103,214 acres. In 1894-95 it was 333,259 acres.

The Muzaffargarh Canals irrigated 239,906 acres in the year 1880-81, in which the Canal Department took over charge from the Deputy Commissioner. In 1894-95 they irrigated 304-730 acres. They are counted as 13 canals, with branches.

The Indus Canals, in the Dera Ghazi district, are 14 in number, of which 4 or 5 have been made by the people since annexation. The area irrigated in 1866-67 was 144,652 acres, and in 1894-95 it was 193,255. The set of the river has made it difficult to maintain the Dera Ghazi Canals.

The Shahpur Canals are five in number, all made since annexation. They irrigated 47,676 acres in 1894-95.

Putting the Lower Sohag and Para aside, as it is in matters of account of a separate class, the rest of the inundation canals described above are classed by the Irrigation Department as the minor irrigation works. We have spent little or no capital on them, so interest accounts on capital cost are not maintained. The profit to Government in their case is deducted simply by deducting working expenses from direct and indirect revenues. In this way they collectively show a net revenue or profit of Rs. 404,094. Some show no profit taken alone, and the rate of profit shown differs greatly. But all are necessary to keep the country they command from relapsing into desert.

In describing the ancient systems of irrigation I have given an account of how cultivation is carried on with the help of these inundation canals. It may be added that in some places, particularly on the Indus, long and strong earth embankments have to be constructed between these canals and the river, to keep out the river floods which would otherwise destroy the autumn crops.

In the case of the Multan and Muzaffargarh inundation canals no water-rates are levied and the old native system of annual repairs of the canal channels and their heads by what is called "cher" labour prevails. Each holding of irrigated land sends a man to work in the gang on his own canal. The gang works for three months, or less, in the winter when the canals are dry. The number of days an individual has to work depends upon the rateable value of his holding as compared with that of the other holdings irrigated from the same canal. A man may either attend himself, hire a substitute to attend, or absent himself. In the last case he has to pay a certain fixed daily non-attendance charge, or fine, called "zarnaga." The money so realised forms a fund out of which expenses of the nature of extraordinary repairs or improvements are met. In the case of the other inundation canals the annual repairs are made by hired labour engaged and paid by the canal officers. In their case a water-rate is levied which is calculated to cover the cost of annual repairs and other expenses of maintenance. The Government looks for its profits in the case of these inundation canals to the land revenue which, more or less, entirely depends upon them.

The inundation canals not managed by the canal officers are almost exclusively in Shahpur and Ferozepur. Those in the former district were mostly made by large landholders some thirty years ago at the suggestion of Captain (now Sir) William Davies, K.C.S.I., who was Deputy-Commissioner of the district. These men execute the repairs by hired labour, water their own lands, and take water-rates, in money or kind, from other people who use their water.

On the left side of the Sutlej, above and below Ferozepur, you will see a long strip of irrigation shown in the map; this is from a group of inundation canals made within the last 20 years, in most cases by the joint labour of the peasant proprietors and their tenants, and in others at the cost of the Nawab of Mandot, a large Jagirdar and landowner. The whole movement was due to the persuasion and guidance of Colonel Grey, C.S.I., then Deputy-Commissioner of the district.

In 1892, these canals irrigated some 200,000 acres. The annual repairs are directed by a small establishment which works under the orders of the Deputy-Commissioner, the people who irrigate supplying the labour, and raising the money to pay for cost of establishment by a rate, which is annually assessed by a meeting of the irrigating landowners to whom the canals are held to belong.

Still further down the Sutlej in the Bahawalpur State, there are a considerable number of inundation canals, a few of which are very large. There were a few here before the Punjab was annexed, but most have been made since, and principally while the State was managed, during the minority of the present Nawab, by Colonel Minchin, and afterwards by Colonel Grey, two officers of the Punjab Commission. It was here that Colonel Grey learnt the lesson which he put to use in Ferozepur.

In describing the rainfall of the Himalayan country I mentioned the existence there of many small perennial irrigation canals, which have been managed and maintained from time immemorial in a customary way by the irrigating communities. There are a number of these also in the Peshawar and Bannu valleys, where they now irrigate as much as 336,244 acres. Those from the Cabul, Swat, and Kurram rivers are of considerable length and size; and a new one has been made from the Kurram in our time, by which a large area of waste has been brought into cultivation. Small establishments, to supervise the working of these larger canals, are maintained under the Deputy-Commissioners at the expense of the communities. There is one other canal not managed by the Irrigation Department, which ought to be mentioned. This is one taking off the Cabul river, which has been lately made from provincial funds, at a cost of 4 lakhs of rupees, and which will, it is expected, very soon pay 9 or 10 per cent. interest on capital cost. Mr. Merk, C.S.I., the energetic Deputy-Commissioner of Peshawar, devised this scheme, and got the owners of the lands commanded to heartily co-operate. It is managed by the Deputy Commissioner, but was constructed in 1892-93 by engineers lent by the Canal Department. It is over 30 miles long, and takes water to a tract the crops of which were formerly very precarious.

I will now return for a moment to the perennial and inundation canals managed by the Irrigation Department. These are some figures I meant to have given, taken from the report for the year 1894-95, which show what a big business the Department has to control.

Length of channels, exclusive of private water-courses :—	
Main canal channels	4,388 miles.
Distributaries	9,130 miles.
Area irrigated thereby in 1894-95 :—	
Paying revenue to Punjab Government	2,781,663 acres.
Paying revenue to native States having shares in our canals..	149,387 acres.
Estimated value of the year's crop on 2,762,112 *acres out of the* 2,781,663 :—	Rs. 7,42,99,588.

The crop values remind one of the fact that even in the cases when these canals do not show in account what a financier would call profit to Government, they add enormously to the food supply and wealth of the population. For most of the land would have given no crop at all without irrigation. The same report shows that the capital outlay incurred to the end of the year on all canals managed by the Irrigation Department was Rs. 7,85,86,288, from Imperial funds, and Rs. 1,49,64,867, contributed by native States.

I promised to give some account of the three great canal projects, not yet undertaken, which are roughly indicated by scarlet lines on the map.

I will take the Jhelum project first, as for that there are detailed plans and estimates, submitted by Colonel Ottley, R.E., and reviewed by Colonel F. Home, R.E,, which have been sanctioned by the Government of India and the Secretary of State. The area commanded amounts to 840,000 acres, almost the whole of which is level and of excellent quality. About 100,000 acres of it are already cultivated in a precarious way. The rainfall of the tract varies from 11 to 15 inches, and the spring level is low, so there is no danger of water-logging. The supply of water in the river is sure, and the silt which it carries is unusually fertilizing. The canal could water annually 50 per cent. of the area commsnded. The cost of construction is put at Rs. 122,70,516, or including interest on capital whilst under construction, at Rs. 153,26,727. The construction of the headworks is expected to prove remarkably easy, and there are no engineering difficulties. An ultimate profit on capital outlay, including interest charges, of 7 to 10 per cent., is confidently expected; but there is doubt as to how soon this would be attained, because rather more than half the area commanded belongs to private owners, not to Government, and it is thought that the extension of cultivation in these private estates would be slow. I myself believe that it would not be so slow as to prevent the project from fulfilling the conditions required to make it rank as a productive work; but it would be as well to wait till Chenàb Canal is completed, and till the prosperity of the settlers on those lands is finally assured.

For the other two projects, there are only rough estimates. The most important of the two is a canal from the Indus, to water the Thull of the Sindh Sagar Doab, an almost desert track of over 5,000,000 acres in extent. This Thull has, from the sand ridges which traverse it, a rolling appearance, like the great Thull, or Indian desert, which runs up the other side of the five rivers, of the westernmost part of which it is, I think, a survival. The intervening country has I think been gradually scooped out in the course of ages by the five rivers and the sand washed away. But the real surface of the Thull is good loam, and the sand rollers do not overlie the greater part. They deserve, by the way, the name of rollers, as the natives say they perceptibly move in a course of years, being driven onwards in the direction of the prevailing winds. The rainfall and spring level of the Thull vary from 10 inches and 90 feet in the north, a few miles below the Salt range, to 5 inches and 30 feet in the south, near where the Muzaffargarh inundation canals begin to run in.

According to the original project, the canal would take off from a deep quiet pool in the rock-bound gorge of the Indus, at the point just above its *débouchure* into the plain. Here it is thought that no weir would be required, but the regulator headworks would have to be very high, as the river rises greatly when in flood, and the channel for the first 40 miles would be in cutting, at first of considerable depth. At the end of this 40 miles it would command at least 4,000,000 acres of the Thull, and would irrigate at least 1,750,000 acres.

The water-rates and land revenue on this area of cultivation would, according to rough calculations, give eventually a return of 9 per cent. on the capital cost of the canal, and much of that cost might be recouped by sale of land; for a large part of the area commanded already belongs to Government, and more would be surrendered by the present owners on condition of a canal being made. The scheme is a magnificent one, but depends for success on the colonisation of the land, the present population of which is very scanty and mainly pastoral. I believe that it will eventually be carried out, but think that the smaller Jhelum project should be taken first. It is better situated for colonisation from the over-populated districts, and is a project of more manageable size.

The third project is for a canal taking off from above a weir to be built across the Sutlej, near Ferozepur, to water the central part of the lower portion of the Bari Doab. This canal, soon after leaving the Sutlej, would cross and closely follow the old bed of the Bias river. I must explain, that at a comparatively recent period the Sutlej flowed some 10 to 15 miles further east in Ferozepur, and the Bias, keeping further west, pursued a solitary course, till it joined the Chenâb. The Jallundhar Doab was, in fact, in those days, some 250 miles longer than it is at present. I have crossed the dry bed of the old Bias in many places, and have seen its banks, and the channels of old water-courses from it, standing perfectly distinct. For in hot, rainless tracts, like the Multan Bar, clay will keep its shape against weather as long as brick will elsewhere.

The area which would be commanded by this canal is about a million acres, which is almost entirely uncultivated and uninhabited. A colonisation scheme would have to be simultaneously carried out. It is estimated that 50 per cent. of the area commanded could be annually irrigated. The average rainfall of the tract runs from 12 inches in the north to 5 inches in the south. The estimate anticipates an eventual profit of 8 per cent. on capital cost, without counting revenue which might be got by the sale of the land, most of which is the property of Government.

It is part of this project that a fifth share, or thereabouts, of the water in the river at Ferozepur would have to be conceded to the State of Bahawalpur, which would be allowed to draw it off by a separate canal on the other bank of the river. There is no doubt that the project is feasible; there are no engineering difficulties. But it is a scheme which would require the most careful consideration. The supply of water in the river in the winter is not nearly so large or so sure as in the case of the other projects, and there are many inundation canals below the proposed head, the interests of which have to be carefully guarded.

I have described these three great projects to show the immense capabilities of extension which still remain in the Punjab. I am not at all in favour of pushing them on hurriedly, in advance of the real needs of the province, merely because they promise to be commercially profitable. I think we should hold them n reserve, to meet the inevitable growth of the population, and not treat them like gold mines o be exploited as soon as possible.

I have now finished my description of Punab irrigation, ancient and modern, and I think hat in the course of it I have proved the proosition with which I began. I may be asked whether I have any moral to draw from that roposition. Only this, that irrigation schemes n the Punjab ought, in my opinion, to be dmitted to stand on a footing of their own; there should be no idea that the Punjab should only get its rateable share with other provinces of the amount allotted to irrigation works from the Productive Works Loan. When it is decided to make a big canal in the Punjab, there should be no possibility of funds being scantily supplied, and work delayed because the Productive Works Loan for the year is limited to a fixed sum. Exceptional provision should be allowed for these great works, as delay in their completion, when once taken in hand, is, of course, terribly bad economy, particularly when, as in the Punjab, colonisation must go on simultaneously. I also wish to urge that the great work done by the canal engineers deserves more appreciation and encouragement than it gets at present, either in India or in England. When I was Lieut.-Governor of the province, the work of all departments came up to me, and my opinion was that no officers did their work in a more scientific and masterly way than the officers of the Irrigation Department. That also I know is the opinion of my successor, Sir Denis Fitzpatrick. And no Department works harder. The chief engineer and superintending engineers have very anxious work, as they are responsible for the success of risky engineering experiments, and for the expenditure of great sums of money. They have no chance of making fortunes, like leading engineers often do in England. The rank and file, the executive engineers and assistant engineers, have hard and responsible work too, and it is always in the plains, where they have to be three-fourths of their time in camp, and out for many hours on foot or horseback in burning sun or steamy heat, looking after irrigation and check measurements, and seeing that every man gets his rights. Very often, too, these officers have in the Punjab to live, when not on tour, in the most isolated places, where for months they may see no European, and where bread and other decent food are not procurable. The result, I am sorry to say, is that the Irrigation Department is very unpopular, and that there is much discontent among the executive and assistant engineers who are in it. They find it impossible to exchange with engineers serving in the ordinary Public Works Department. Engineers of the latter class almost always have their offices in big stations, where there are more comforts and some society, and they get to the cool climate of the hills much oftener. So they refuse to exchange. Some compensation in the way of superior pay ought, I think, to be given to the officers of the Irrigation Department, certainly to those who are condemned to lead isolated lives in out-stations. When I, as Lieut.-Governor, was assisted by Colonel Ottley as Chief Engineer, we proposed to the Government of India that such out-station allowances should be granted. The proposal was not approved on the ground that it would be impossible to restrict it to the Punjab, but I venture to think that the money would have been well spent and that it would pay to grant out-station allowances to P. W. officers all over India. The Punjab canals pay so well that the officers seem to have a claim to liberal treatment. In the matter of honours, too, I think the work of the engineers should be more noticed than it is. In former days Sir Proby Cautley and Sir A. Cotton were knighted, but of late except a well-deserved C.S.I. to Colonel Fred. Home and C.I.E.'s to Colonel Robert Home, Colonel Ottley, and Mr. Maclean, I remember no honours given to officers of the Irrigation Department, Yet their work in the Punjab is, as I have asserted, our greatest achievement in the way of material improvement of a province. Greater than that of the railways, though as we found in the case of the Chenab Canal, railways and great irrigation canals must go hand in hand. We have had to make a new railway in hot haste to carry away the produce of that canal.

Fifty years ago it was said that if our rule in India were to come suddenly to an end, the only trace of it left in a few years would be fragments of bottles and tin cases. A glance at the big map will show how little true this is now in the Punjab, where our canals and railways throw their huge masonry weirs and long iron bridges across the largest rivers, which no former Governments thought it possible to control, and bring life and movement into tracts which were formerly mere scrub jungle or bare desert.

All this progress, and the expansion of population which goes with it, depend for very life in the Punjab upon the maintenance of a strong and highly organised government. If English rule ceased, the inevitable conflict of races and creeds would produce anarchy and the greater part of the irrigation of the province would speedily become a thing of the past, as has happened in Mesopotamia, where vast tracts once highly irrigated are now a desert as bare as that which we see in passing through the Suez Canal.

DISCUSSION.

Mr. T. H. THORNTON, C.S.I., (formerly Secretary to the Punjab Government) heartily thanked Sir James Lyall for his valuable paper. From that paper it appeared that, in addition to a large area irrigated by wells and water-courses, there were in the Punjab, at the present time, nearly 3,000,000 of acres irrigated by great canals, scientifically constructed and managed. The extent of such irrigation in the Punjab was thus considerably greater than the total canal-irrigated area of Lombardy, and many times greater than that of Spain. This, in the case of the Punjab, was the great result of a policy steadily pursued for years by the British Government, and the credit must be shared among many distinguished administrators and engineers; but to Sir James Lyall belongs the credit of having been the first, or one of the first, to work out, in conjunction with scientific irrigation, the difficult problem of scientific colonisation. Few passages in the paper are more interesting than those describing the Sidnai Canal and colonisation scheme, and the splendid success attained. There was another fact mentioned in the paper deserving of special notice, the fact that the remodelling of the Western Jumma Canal and the drainage of its waterlogged area, had, at length, been completed. The condition of the inhabitants of this fever-stricken tract had, for years past, been a reproach to the Government, and all must be glad to hear of the great improvement that has taken place. He also observed with pleasure that a policy he had long advocated and had recommended in a paper read before the Society in 1888, the policy o gradually withholding irrigation from the uppe tracts, having a rainfall of over 25 inches, and passing the water down to the drier tracts where irrigation i more required and less likely to be noxious ha been of late years adopted. He was also glad t notice the success attending the completion of th Swat Canal. This canal, though a small work, wa one of political importance, for it had the effect o placing on our immediate borders a colony of sturd peasants, engaged in peaceful occupations, in locality formerly overrun by robbers from the hills. He (Mr. Thornton) well remembered, in the col season of 1870, accompanying that distinguishe engineer and administrator, the late Sir Henr Durand, in a march through the dreary plains Yusufzai to the banks of the Swat River, and wa by his side when he decided to recommend the pr ject. But the paper was not only interesting an account of great works accomplished, it w even more interesting for its programme of st greater works in contemplation; but time d not admit of further comment. All he could d was to congratulate his old Province on the gre future before it. He expressed his full concurrence Sir James Lyall's remarks on the scant recogniti of the services of canal engineers, and instanced t case of General Crofton, R.E., who, after taking important part in designing and constructing the great Bári Doab Canal and in remodelling the Ganges Canal, was allowed to retire, after years of arduous work, without any recognition at all. There was one matter, a very important matter, connected with irrigation, regarding which Sir James Lyall had been almost silent. He had said little or nothing about its effect on the health of the population. Yet there was some ground for anxiety on this subject. All knew the terrible effects of over-irrigation in the Western Jumna area and parts of the North-West Provinces. A late Sanitary Commissioner of the Punjab (Surgeon-General Bellew) had given a very serious account of the effects of canal irrigation there, and the mortuary returns of the province were certainly not encouraging. From these returns it would appear that the mortality from fevers (that is, chiefly, malarious fevers) tends greatly to increase. The returns for 1882 show a mortality from fevers of 346,680 persons—a large number; but those for 1892 show a mortality of 718,890 persons, though the population during the period had only increased by about 10 per cent. The year 1892 may have been specially unhealthy, but a comparison between the mortality of two quinquennial periods, viz., 1882-6 and 1889-92, shows similar results. In these circumstances he would ask Sir James Lyall whether he could give any further information on the subject; and also state whether any special measures (other than those mentioned) had been taken—such as improvement of drainage or prevention of excessive irrigation—to guard against the extension of malaria.

Mr. ROGERS asked how the crop rents were levied—whether they were fixed on the value as a whole, or whether they had to be levied separately every year by measurement; and if so, who was responsible for the accuracy of the measurements?

Sir JAMES LYALL said they were assessed by annual measurements, and in every case the canal officers were responsible for the accuracy of the returns. In one or two cases the work was done by civil officers.

The CHAIRMAN said, if Mr. Rogers would look at the "Irrigation Report" for the Punjab or the North-West Provinces he would find all these points explained in great detail. They also showed that the complaints made as to the insufficiency of measurements were something very small.

Sir JAMES LYALL said, with reference to the sanitary effect of irrigation, that there was no doubt that at one time the sanitary effect of the Western Jumna Canal was very bad, but that had been amended, and now the water was being mainly diverted into a dry country, with a deep spring level; it was not likely that irrigation would do any harm there. In the same way with other canals, the irrigation on the Bari Doabs was mainly in tracts of light rainfall, where the spring level was deep; and he had no reason to think it produced sickness or fever. Perhaps the air would not be quite so good as it used to be, but there was no reason to suppose that it would produce malaria, because the experience of the engineers was that if they kept the drainage channels open, which they were very careful now to do, no harm would result.

Mr. TAHL RAM, as a Punjab zemindar, desired to say a few words in recognition of the services which Sir James Lyall had rendered towards advancing the agricultural condition of the province. If they were indebted to him for one thing more than another it was perhaps the opening of the Chenab Canal, by which the condition of the agricultural classes had been much improved. If English people wanted to utilise their capital they could find no better way of doing so than by investing it in irrigation works in India. India required that her material resources should be greatly developed, more especially by irrigation, because that would benefit the agricultural class, and produce contentment.

The CHAIRMAN then proposed a vote of thanks to Sir James Lyall, which was carried unanimously.

Mr. A. ROGERS writes:—I was informed in answer to my question in the course of the discussion on Sir J. Lyall's paper on "Irrigation in the Punjab," that the method of payment for water privileges was by the way of crop-rates, that is, rates varying according to the crops raised, the extent of which crops was ascertained by annual measurement. If this is strictly the case, the system appears crude, and open to the most serious objections, as it must give many opportunities for fraud to lowly-paid subordinates, which their inferiors, owing to the large canal areas placed in their charge, could never hope to put a stop to. This system is not universally adopted in India, and I am now engaged in collecting information of the systems adopted in other parts of the country, and in Italy, to assess water charges on the land, with a view to the general adoption of some one that may appear, on comparison with others, to be the most advantageous in the interests of the State, as well as of those who use the water provided in its canals.

Dr. VOELCKER (Royal Agricultural Society of England) writes:—The contrast which Sir James Lyall has set out in his paper, between the condition of a district unsupplied with means of irrigation, and that of the same district after the introduction of irrigation, has been in no way over-stated. Certainly, one of the points that impressed me most, when making an agricultural tour in India in 1890, was the difference between the land that lay on the one side of the railway line between Multan and Rashida, and that on the other side. This is the district referred to by Sir James Lyall as having been successfully colonised since the Sidhnai Canal had been brought there. On the one side of the railway line there was irrigation and agricultural prosperity, on the other side no irrigation, and consequent barrenness and desert. No one, too, could see the market-gardening around such towns as Amritsar in the Punjab, Poona in Bombay, or Hospet in Madras, without being impressed with the beneficial results of the introduction of canals for irrigation purposes. It would have been interesting had Sir James Lyall given us in his paper a comparative sketch of the appearance of the Punjab before and after the carrying out by English engineers of the great works of canal irrigation, and if he had stated the respective areas then and now under irrigation, the crops produced, and the agricultural populations engaged. Inundation canals were, I believe, ordinary means of irrigation in the Punjab before the time of the English occupation of the country, and it is a somewhat remarkable fact, too, that when we come to well irrigation we find that no modern mechanical device has been any improvement on the old Persian wheel, or has succeeded in replacing it in any way. In speaking of canals, a great distinction should, I think, be drawn between those which are merely carriers of water to the land and those which are laden as well with rich silt. The former may lead to overcropping of the land and the removal of valuable soil constituents from it, while the latter provide, as it were, a fresh rich surface to the land which is far more effective than many applications of manure to it. Nor must the point be omitted which our Chairman, in his opening address, alluded to, but which Sir James Lyall, in his paper, has barely touched upon, viz., that canals are not an unmixed benefit, for, while they may bring agricultural prosperity, they may also (partly through faults in alignment and construction, and partly from the changes which their presence necessarily produces in the condition of the surrounding soil and country) bring with them many evils, such as the water-logging of the soil, the spread of the salty efflorescence known as *reh*, and ill-health to the inhabitants. The balance of good, I fully admit, lies strongly in favour of the spread of canal irrigation, but the attendant evils call for the exercise of continual care and foresight in marking out the lines of new canals. However good, too, the cultivation by canal irrigation may be, it does not, in my opinion, come up to the excellence of that by well irrigation. A further point to consider in relation to the spread of canal irrigation is that, except in the case of silt-laden canals, the important question of the supply of manure to the land must be taken in conjunction with it. Water without manure means ultimate poverty of the land, just as manure without water is useless. The supply of the two must go on hand-in-hand, and the two problems will have to be considered together. I quite agree with Sir James Lyall in his forcible comments on the hardships undergone by the officers of the Irrigation Department, and it certainly does seem an anomaly that a man who, had his lot in early life been cast in England, might have risen to high eminence in his profession and to social distinction, has in India, be he ever so capable a man, so little chance of distinguishing himself or of reaping a reward commensurate with his talent. From one statement of Sir James Lyall's in his paper I must dissent, though with considerable diffidence, on account of the comparatively small acquaintance I have with India as a whole. Still, I should be inclined to doubt whether of all parts of India it is the Punjab where canal irrigation is most necessary. That canal irrigation may there be most remunerative, I do not doubt, but it was impressed upon me during my tour of 1890 that the parts which really needed irrigation the most were not those that were the driest, and, of course, not those either that had the most rainfall, but those districts that were the really precarious ones. There are the districts where rain sometimes comes and sometimes fails, such districts, for example, as are situated on the edge of the monsoon, and where the people will grow crops on the chance of rain coming, while if it does not come, a famine, or at least scarcity, ensues. In the wettest parts there is no fear of failure, and in the driest parts the crops are not put in unless there is enough rain or water in some form, for them, but it is the precarious tracts that it should be the aim to supply with water and so render famine an impossibility there. And so, when Sir James Lyall speaks of the desirability of the Punjab irrigation schemes standing on a footing of their own, I feel a little afraid that the "remunerative" idea may be pushed too far in the matter of canal irrigation, just as it has been done in that of Forest administration, to the exclusion of the wider and imperial question of the supply of irrigation to those parts of the country which need it for the very existence of the people, the cattle, and the crops.

ELEVENTH ORDINARY MEETING.

Wednesday, February 19, 1896; SIR OWEN ROBERTS, M.A., D.C.L., F.S.A., Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

De Albuquerque, John Predozod, Government Laboratory, Barbados, W.I.
Haydon, William, 113, Loughborough-park, Brixton, S.W.
Hosken, Josiah R., Department of Mines, Georgetown, Demerara, B.G.
Woodthorpe, Colonel Robert Gosset, R.E., C.B., Junior United Service Club, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Bird, Arthur George, Ellerslie, Roath, Cardiff.
Henderson, John McClelland, Ph.D., Glendon, Kingswood-road, Norwood, S.E.

Jonas, Alfred C., Fairfield, Poundfald, near Swansea.
Parfitt, George John Tom, The Avenue, Keynsham, Bristol.

The paper read was—

THE REPORT OF THE ROYAL COMMISSION ON SECONDARY EDUCATION.

By H. Macan, M.A.

It is not of course my intention to-night to deal exhaustively with the contents of the nine volumes of the report, as such a proceeding, irrespective of the fact that my paper would last for 24 hours, would necessarily involve the rewriting of the actual report as contained in Vol. I. Nor do I desire to even abstract Vol. I., as has been done well, yet concisely, by the National Association for Promoting Technical and Secondary Education; for such an epitome I must refer my hearers to "The Record of Technical and Secondary Education," for January, 1896. My object will be to take the report as a whole, and accept it not only as the result of an exhaustive inquiry, but also as a working compromise between conflicting interests arrived at by reasonable men. If I accept it, as I do, without evasion, equivocation, or mental reservation whatever, I must, I suppose, be prepared to show that I have read it—every word of it—that I understand it, and that I am prepared to defend it. The last point is the more important, and therefore to a *defence of the salient points of the Report against the chief attacks made upon it* will this paper be more particularly devoted. The points which I will take in order are:—

1. The differentiation between secondary and primary education in respect to (*a*) authorities, (*b*) schools, (*c*) educational functions and subjects. [These subdivisions, of course, more or less depend upon each other, and although illustrated with three diagrams, on the wall, showing broadly the proposals of the Commission on each of them, cannot be treated absolutely separately.]

2. The financial proposals of the report, as likely to be treated in Parliament.

3. The functions of the State as regards education, with special reference to private schools, their claims, and their future.

Now, in the first place, it must be noted that the Commission in their terms of reference were told "to consider what are the best methods of establishing a well-organised system of secondary education in England...." The complaint, therefore, of Dr. Gow, of Nottingham, in his letter to the *Star*, at the head-masters' conference, and at the teachers' guild, that the Commission has produced a Local Government Bill, and not a scheme of educational reform, is quite beside the mark; the natural corollary to his proposals —and he had the courage of his convictions— was the further suggestion that the Commission should propose to bind secondary teachers with ropes, which he called Codes. Finding scant sympathy with this from the educational point of view, he has now made it plain that these codes were for the inspectors, not the teachers, and that his real object was, in fact, to handcuff the policeman. My friend, Professor Armstrong, fell more or less into the same error in his article in *Nature*, where, while praising in a most handsome manner the Commission for what they had done, he complained that they had not poached upon his own preserves and infringed his own copyright, by preaching at greater length than they did upon his special texts of "method not facts," "character and not examinations;" but surely the creation of a "system" demands the erection of machinery capable of performing its functions with competent foremen to work it rather than the feeding of the furnace with fuel, the oiling of the wheels, or the selection of the colour or pattern of the raw material from which it is to manufacture the perfect fabric. Given proper authorities with ample means and fixed duties, it is the fault of the body of the teaching profession if they cannot educate their old masters sufficiently to allow them to educate aright the young masters of the next generation. If the governing classes of this country cannot see that methods, which teachers with one consent agree to be wrong, cannot be made right by Departments or Grants, no Commission can teach it to them, and the sooner, as a nation, we hand in our checks and resign the leadership of civilisation to Germany and America, the better will it be for civilisation itself. Hence a "system" has merely to put competent administrators into responsible positions, and instruct them to consult competent teachers.

Again, to establish a system (at present non-existent) of "secondary education," naturally precluded the disestablishment of the existing system of elementary education, which, to the minds of everybody except the *School Board Chronicle*, would have been a necessary corollary to proposals for the union of both grades of education.

But it is objected by some that the Commission did discuss this union at the centre, and agreed to it, although as they neared the circumference of the educational circle, the primary and secondary radii grew farther and farther apart. It is, of course, not sufficient to reply that this is a natural and physical peculiarity of radii in general. But it may be pointed out that the Commission had practically no option, as regards the unity of the central authority; for successive Commissions on Endowed Schools, Science and Art Administration, the Charity Commission, Elementary and Technical Education, as well as Parliamentary Committees on the same subjects during the last quarter of a century, have agreed that this step, at least, was essential to prevent the waste of power going on among the Departments at head-quarters. It may be interesting, as an analogous instance, to draw attention to the fact that, in the recent scheme of re-organisation of our military administration, steps were taken to draw together all the threads into the hands of the general staff at head-quarters, while leaving the greatest amount of freedom to the specialists of very varying qualifications who commanded the troops constituting the different arms of the service.

The conception, set out in the Report, of the central authority—its parts and its relations to the local authorities—with their parts and functions, I have sketched in the diagram on the wall (A), which I will briefly explain. You will note how it lays stress upon this centrifugal theory of local action. Let me draw particular attention to the position of the—

Educational Council,
Non-local school managers,
Continuation school managers.

But the attack upon the *local authority* proposals of the Commission is only a part of another attack bound up with it, which seeks to decry the report because it has not said that all education is one and the same. This, in the language of the National Union of Teachers, its chief exponent, is called "grading schools to grow organically one out of the other." The contrary conception of the Commissioners of the relation of schools, and consequently of scholarships, their connecting links is set out in the diagram on the wall (B), upon which I will now briefly comment.

I will here draw particular attention to the—

Scholarship ladders, the
Higher grade school properly understood, and the
Large opening for private schools.

It will be observed that at the foundation of the whole scheme lies the dictum of the Schools Inquiry Commission (p. 178):—"Instruction, when most suitably ordered, is not one continuous piece of which any length cut at discretion can yet be a whole;" and (*ibid.* p. 94) "The three grades of schools do not lead one into the other, but stand side by side, starting, it might be said, from the same point, but leading to different ends." The opposite policy, the policy of fusion and confusion, regards education as a kind of French loaf, from which you appear to cut off slices indefinitely, all of similar nature and quality, or, perhaps, rather as resembling some of those lower organisms, which propagate themselves by fission, each section cut off soon performing the functions of the entire animal. These comparisons no doubt primarily apply to the connection between elementary and secondary education, and to the creators of certain higher grade, organised science, and technical schools, it may be as well to point out also that the Commissioners on Endowed Schools gave us a reason for these conclusions (p. 578):—"The differences in the ages at which the instruction in school is to stop makes a difference in the whole character and plan of such instruction."

The same idea is conveyed in the Report at present under consideration, where it says (p. 136):—Secondary education "is a process of intellectual training and personal discipline conducted with special regard to the profession or trade to be followed;" and again, "Secondary education therefore, as inclusive of technical, may be described as education conducted in view of the special life that has to be lived, with the express purpose of forming a person fit to live it." Hence *respice finem* is the motto of real secondary education. And here it may be noted that these definitions are simply an extension of Matthew Arnold's well-known saying that "technical education begins in the secondary stage." In the diagram on the wall (C) I have endeavoured to show concisely the connection between the grades and the subjects or curricula. Briefly stated it may be said that technical, commercial, or linguistic education are simply vertical sections cut out from the horizontal stratum known as secondary. But the opposite, or "organic continuity" theory goes a step farther and reveals to us the reason for the plea for one local authority and one stamp of education; it is that the teachers may be one; in short a trades union argument. The revelation of this motive is set forth in all its baldness in the *Schoolmaster* of January 25th, where we read of the President of the Metropolitan Board Teachers' Association supporting the School Board as a local authority for secondary education because "if the secondary schools were managed by bodies other than the School Boards, Board teachers would not stand much chance of appointments in them." Here we have the whole programme; one education, one authority, one teacher. In short, in the language of Trilby, a policy of "the altogether." This, no doubt, would clothe the dry bones of elementary education with the flesh of increased grants and of social recognition, but would, at the same time, leave the secondary school proper naked — and ashamed.

I will now take up my second point, that of finance. I may say at the outset that I am not in favour of raising or spending large additional sums of money either from rates or from the imperial treasury until all existing funds are utilised to the full. I agree with the recommendation of the Commission (No. 145), and not with the memorandum of Mr. Hobhouse, M.P., or the resolutions of the Head Masters' Association. I do not consider that a very large amount of public money is required if present funds are properly utilised. The local taxation grants, the charities, and the rates are the new public sources looked to by the Commission; but they have forgotten a fourth source, the voluntary liberality of our wealthier citizens. The £100,000 subscribed in Wales within a few years, the gifts to County Councils by men like Mr. Brunner, Earl Cowper, and the Duke of Bedford will, by the force of example and the enlightenment of public opinion, bear increased fruit in a more developed and stable system. What has been voluntarily contributed in my own county (Surrey) towards the higher education I will set out in detail later on. In fact a 2d. rate, without any Treasury contribuion, appears to me more than enough. Let me deal very briefly with these present sources of income.

The Local Taxation Grant of course must be wholly and entirely devoted to education at once. No measure for the relief of agriculture should be allowed by the friends of education to pass in the Houses of Parliament unless linked with conditions which will stop once and for all the raids and incursions of the agricultural "Jamesons" across the frontier of their own knowledge, and into the province of educationalists and their legitimate resources. Middlesex, Gloucestershire, and the North Riding should no longer be permitted to starve education and make educational organisation a farce.

Next, as to the Charities. Readers of the Report and of the evidence will note that, outside those persons connected with the Charity Commission, I was the only witness who dealt fully with the question. This question is a very important one in Surrey, as the following facts will prove. The Commissioners publish statistics which show that if all possible endowments legally applicable were appropriated to secondary education, the total would be only £12·2 per 1,000 of population, the lowest in England except Sussex and Cornwall, the average being £25·1 per 1,000, excluding London, where it is £61·5 per 1,000.

But the total possible secondary education endowment in Surrey put down by the Commission is £5,126 a year, while that actually so applied is only £1,447; hence the county utilises at present only five-seventeenths of its total endowment for secondary education. My calculation, given in evidence, that the non-applied Surrey charities would give secondary education (at £10 a head, of which fees would provide £4) for 660 children practically agrees with the figures arrived at by the Commissioners, which work out to 613 as the number of scholars which might be thus served.

The Commissioners (on page 177) quote my evidence in support of their views. That £300 a year at Chertsey and £400 a year at Egham, not to mention less sums elsewhere, left for education, should go into the ratepayers' pockets is nothing short of scandalous. It is true, as Mr. Hobhouse says, that touching these questions is unpopular and my Committee has incurred unpopularity no doubt by its attempts, frustrated at present by the state of the law, to put things right, but certainly if they had the power no such considerations would stand in their way. There is no safer motto in matters of education than "whatever is popular is wrong." A local authority which refused to tackle the question of charities, would certainly refuse to raise a rate. Certainly it appears to me that the present power of differential rating possessed by county councils should be retained so that those districts which continue to use charity funds for the relief of the ratepayers should be more heavily taxed, than those which use these charities for education.

Next as to the rates. It is quite untrue to say, as some do, that the Commission proposed a *new* rate. County Councils have at present the power of a 2d. rate in all urban districts, and this power is simply to be utilised for enlarged purposes. The County Council can raise a 1d. rate over the whole county, the urban authorities (in whose districts are practically the whole of the secondary schools) can raise another. To use this rate for adding a few literary subjects to those which at present can be taught under the Technical Instruction Act, is a very different thing from adding on a new rate. What can be done at present by the use of this double power? You can see from this picture, which represents the County School, Richmond, put up for Secondary Education by the joint efforts of the Town and County Councils.

But here we are met with the one proposal of the Commission, which cannot and will not pass into law, and that is the power of demanding a rate. The new Local Authority is recommended to be given the power of demanding, in addition to their other sources of revenue, a rate not exceeding 2d. This rate is to be raised by precept on the County Council. I strongly deprecated in evidence any compulsion in the matter, as I hold that, secondary education not being compulsory, the ratepayers would never consent to any other authority, however representative, forcing the present rating authority to take compulsory action. Every local authority, whether county council, town council, and school board, oppose the creation of a new rating authority. The House of Commons will most certainly give the County Council the power of vetoing the rate; and this is the general view of the witnesses before the Commission. But possibly they were wise in asking the maximum of power possible. It appears to me that teachers also would be well advised to consent to this rating power of the local authority being removed; for it does not appear to have struck them that it is this very rating power which prevents direct election of teachers on the local authority. Everybody practically was in favour of this direct election, but the House of Commons would not stand for five minutes such a violation of the whole spirit of the Constitution, as for a special class interested in spending a rate having a peculiarly favoured position upon the body levying that rate. I believe that the abolition of compulsion in the rate would largely remove this fatal objection. What will not help to remove it, is, as some fondly imagine, the preliminary passing of a Registration of Teachers Bill. Such a Bill might form a register which would be a "Legion of Honour," as the Commission recommend, or a "refuge for the destitute," as the College of Preceptors appear to desire. If, as an eminent member of the Commission said to me, a well-known teachers' association now existing tends to become a "trades' union limited," a register of all existing teachers would certainly be at once a trades union unlimited; and, as we know, such bodies shape their policy for the benefit of the majority of their members, and with a view to the survival of the unfittest. No such body would ever be given the power to demand a rate.

I will not go into the question of fees, but a ratepayer or a taxpayer will demand that, as he pays his annual £2 towards the early education of the children of others, he has a right to a *pro rata* reduction in the fee of the State schools for the later instruction of his own children; and the demand will be satisfied.

Now I turn to the final point with which I wish to deal, namely, the functions of the State towards secondary education, with special reference to the position of private schools. The fight over the report of the Commission, when its recommendations crystallize into a Bill in Parliament, will turn very largely upon this question, not, however, from the point of view of those copious writers in the public Press who daily advocate the claims of private schools, but rather from the point of view of that mysterious person "the ratepayer," whom one never meets in private life, but who, in the abstract and in the gross, is always on the side of spending no money upon anything. I do not propose to discuss the report of the Commission merely as the first unanimous document issued by politicians of all schools, advocating direct State interference with, and assistance to, secondary education, though it is sufficiently remarkable if regarded in this light. Public elementary education rendered public secondary education but a matter of time. The substitution by the nations of the world of the competition of the markets for the clash of arms as the sphere of their rivalry and conflicts made it essential for the fittest to survive by the strength of brain power and by the training of the intellect. Hence it came to be recognised that the State had no more right to trust exclusively to private effort for its schools than to the volunteers for its army, or to the dockyards of the Tyne or the Clyde for its ironclads, or the arsenals of Birmingham for its small arms. The secondary education of a nation is its first line of defence, its technical education the advance guard of its offensive forces. But it is objected in one quarter that secondary education is for the middle classes, it being assumed that any one who does not send his children out to work at the age of thirteen belongs to a disreputable body called the middle classes. But why not for the middle classes? What wrong has the "poor man in a black coat" done, except that he votes for what these persons call the wrong side. As Mr. Diggle put it in Liverpool about four weeks ago. "Educationally considered, the poor were amply provided for; the rich could to a large extent take care of themselves. But the great middle-class had been overlooked, and its wants systematically neglected. It was now time attention should be directed to the formation of that system of secondary education which would meet their needs." And why should the State, which requires an educated people for its own sake as much as for theirs, refuse to aid? In the words of Dr. Wormell at the annual conference of the Head Masters' Association, "the technical education movement differs from previous educational movements in being not eleemosynary, but designed to provide opportunities for all who want them, of gaining the higher scientific knowledge and skill whereby their labour will have the best channel of fruitful and profitable development. The State needs this higher skill, and finds it must provide the means to produce it; but it matters not to the State whether this knowledge and this skill are developed in the hands of one whose parents earn £100, £200, or £300 a year." Driven from their outposts of the old Adam Smith days and leaving behind them as a kind of rear guard, Sir Richard Temple and Sir Edward Clarke, our obscurantists fall back upon the almost invincible stronghold of ignorance, and tell the Commission "we do not admit that new schools will be wanted" and "our opinion is that no deficiency exists" (*vide* evidence of Private Schools Association), and again, in reply to a series of questions as to their arguments used against the local authorities supplying only schools out of public funds, we have the admission: "We are not able to bring evidence to show whether or not deficiency does exist." If there is anything more than another which all the evidence, from every person with opportunities of judging from experience of any large area, proved to the commission, and upon which all assistant commissioners were agreed, it was the lamentable deficiency of second and third grade schools, the want of plant, apparatus, and equipment for those existing, and the low salaries which had to be paid to assistants owing to the lack of endowments; a deplorable deficiency everywhere.

The assistant - commissioner in my own county of Surrey notes the want of no less than eleven schools, four of which are, however, either now supplied, or in process of being so. My own calculations go to show that of those children who use second and third grade schools, or, in other words, whose parents can afford to pay from £4 to £10 for an education costing not less than £9 and up to £15 a head, there are, in that county, about 4,500, of which the present schools, nearly all practically full, account for only about 1,100 for boys, and 300 for girls, thus leaving above 3,000 children to be provided for; the four new schools I have mentioned (of which I give you illustrations of the two largest) will account for about 800 of these. As the total endowments of the existing schools (exclusive of the four new ones), as I have shown above, is only £1,447, and as the cost to the County Couucil of keeping these schools in a state of efficiency, and paying the fees of a few scholars too poor to pay anything, is over £4,000 a year, and it is not too much to say that if we provide for the 3,000 at a cost of £12,000 (or a 1d. rate), and get an average of £6 each from the parents, we shall be meeting this deficiency as cheaply as possible.

But I shall be met by the arguments that either there is no such deficiency because the private schools admirably educate all these children at present, or that if they do not, they could do so, if assisted on Irish or Danish principles. This brings me to close quarters with the private school position; and on this point there is great need of plain speaking.

Day by day we read letters in newspapers and speeches at meetings in which it is urged that a determined attack is now in progress upon the liberties of England, and that the only defenders of these left to us are members of the Private Schools Association, a body whose importance and representative character may be judged from the fact that whilst its publications claim that private schools are at least 15,000 in numbers, only 700 members (not all of them principals) belong to the Association, now in the thirteenth year of its existence, and of these members only 345, or 2·3 per cent. of the whole body of schools, felt sufficiently secure of their own efficiency to send in any particulars to the Royal Commission; the three tailors of Tooley-street about as adequately represented the British Empire.

Now before dealing with the arguments of these gentlemen, who have a chameleon-like existence, writing one day to the *Daily News* under the initial A, another to the *Times* under that of B, and a third to the *Standard* under the name of "Walker," I must let a little light in behind the scenes of the Report in order to repel the insinuation that the Commissioners did not take the greatest trouble to find out all about these schools, and did not treat them with the greatest tenderness. All over the country representatives of public authorities were harassed by the Commissioners to obtain statistics of these schools, the names and qualifications of principals, and the numbers and ages of children in the schools; these returns were checked by the secretary with directories, lists, and books; assistant Commissioners were sent down to ask for explanations of omissions, to ferret out if possible additional schools, or to check particulars. Voluminous evidence was thus obtained; it was impossible to publish this in the interests of these schools themselves; the nakedness of the land would have been too apparent. The trouble which had to be taken to obtain any statistics at all was enormous, so many of the schools lurked in recesses and shrunk from the public gaze. Again, oral evidence given against these schools, showing the type of building so familiar to us in London suburbs, and the type of men who manage them, was ruthlessly modified in the witnesses' presence. Again, Dr. Wormell, whom I mention with the greatest respect, and who held a double brief, for the Head-Masters' Association and for the Private Schools, interpreted his instructions as if the former brief (like the little tin soldiers) was marked 1s. 9d., while the other was 2s. 3d., and put at least three-fourths of his questions in cross-examination in the interest of the Private Schools; he also produced a kind of dissentient memorandum, which proved that Private Schools competed successfully with even our highly endowed universities, but that these schools introduced into secondary education the subject of slojd, a subject which every child knows is only suitable for primary education. Several of the Commissioners, notably Mr. Sadler, Mrs. Bryant, Prof. Jebb, and Mr. Lyttleton, had previous to their taking seats on the Commission spoken strongly in favour of the work of these schools; but this was before the Commission; because these same eminent authorities, after they have had the facts put before them, report that there is a deficiency, which the State alone can fill and must fill, they are assailed with abuse. Their "ignorance," we are told, "is essential," they have a "terrible want of insight," they are "reluctant to part with prepossessions and prejudices," and they "suffer from blindness." That the Commissioners have been driven from their "prepossessions" in favour of private schools by the evidence of the very persons who represented that interest, and have had their eyes opened to the attempt to foist upon the nation proposals for legislation in favour of a vested interest, would be the correct representation of the facts. From no other quarter, except from the elementary school party, with which I have already dealt, have the Commissioners been so persistently attacked; hence the length at which I have thought it necessary to defend them. I need scarcely say I do not include "Proprietary" schools in the term "Private," as the head masters of these belong to the Incorporated Association of Head Masters, and have taken no part in this attack on the Commissioners.

Now, theoretically, private profit schools, or rather schools conducted for private profit—with the accent on the word "conducted"—have no business to exist at all; their existence is due to an entirely false view of education, which regards it as an article of commerce—something to be bought and sold across the counter. Now, every true teacher knows it is nothing of the sort, and that, consequently, even the axioms of political economy do not apply to it; for instance, it does not obey the *laws of supply and demand:* in education the supply must precede the demand. Does anybody suppose that the working classes of this country would ever have demanded public elementary schools, if first the Church, and similar voluntary agencies, and then the State had not supplied them? Why, even at the present day, in whole districts in England, if the classes using these schools were polled on the question, they would vote for closing them, and for making money by child labour instead. Again, education cannot, if efficient and effectual, be self-supporting, much less paying; for its whole object is to raise the people — that is to say, to give to a class, who can only afford to pay for, say, a £4 education, a better kind which was previously the monopoly of the class above, and cost £10. Nor is this, as persons like Sir Richard Temple suppose, a consideration affecting only the poorer classes and the public elementary schools. The upper and upper middle classes, whether educated at Eton and Cambridge, Winchester and Oxford, or at the Grammar Schools of Manchester or Bedford, or the University Colleges of Liverpool or Leeds, get an education far below ts cost price, owing to the munificence of pious founders, or benefactors; in the case of the University Colleges, they share in a State subvention as well; even that happy hunting ground of the little taught but much examined private schoolmaster, the University of London, has its expenses guaranteed by he State. No argument has ever been adduced to show that the lower middle classes, who bear the chief burden of taxation, should be placed in a different educational position from the classes above them, to whom hey pay ground rents, or the classes below hem, whose children they now educate free.

But further, the maxim of political economy hat you should "buy in the cheapest market nd sell in the dearest," does not apply to ducation. On the contrary, the best teachers ave bought their own education in the dearest market, the universities, and sell it in the heapest, namely, schools for the poorest lasses. Private schoolmasters who so often *vide* Mr. Headlam's report on Surrey) have ualified themselves or, rather, have been ualified by the State to give an efficient *rimary* education, and on the strength f this start a *secondary* school, for which hey are not qualified, are simply working pon the trade and not the educational prin- ple. For by making education private, e do not, *ipso facto*, make it secondary. inally, the principle of the ready money ealer, "small profits and quick returns," has o place in education, which is assuredly a rowing of the bread upon the waters not return until after many days. From this follows that annual result payments "for oods delivered" on the principle of govern- ent contracts with railway companies for arrying troops or mails have no place in lucation, for it is not possible to tell if the ontract is carried out, and the child educated n proper lines until many years after. The ttenness of the Irish intermediate system, by hich bonuses of from £10 to £15 are given to teachers of any class of school for each pupil who passes a particular examination, and which is one that the private teachers wish to introduce into England, lies in its practical denial of this truth.

If one can imagine all the worst points of the London University Examinations and of the old South Kensington payments by results alone (against which every real teacher has fought) rolled together, and unlimited cramming in constant preparation for what Mr. Eve in his evidence called an "annual Armageddon" it is possible to conceive the Irish system. It was founded on a saying of Lord Cairns, which, being translated, is simply the old Jesuitical motto, "that the end justifies the means," quite the worst possible motto for a true educationalist. Matthew Arnold condemned it in strong language, and to-day it is so crying an abuse that practically all the upper middle-class and most of the lower middle-class in Ireland send their children to England to be educated; I am speaking here from experience of many branches of my own family who live, or have lived, in Ireland. In fact, I will go so far as to say that much of the separation and fued between the middle and the lower classes in Ireland is due to this absenteeism of the younger generation arising from the deplorable state of secondary education. Mr. Bryce put the case quite plainly to the private school witnesses when he told them that it was only tolerated there owing to the "denominational conditions of Ireland," and that "strong objections had been taken to it." For these pioneers of progress, these exponents of educational freedom, to recommend such a system in England is simply to preach the true Gospel to others while themselves bowing down in the temple of Mammon.

After Ireland we naturally take Denmark. Now the remarkable thing about the Danish system is this, that no evidence on the question was given upon it before the Commission; it is, of course, well known that witnesses chose their own lines of evidence, and that anyone could send in a memorandum upon anything. I, for instance, sent in one which was duly suppressed, but its main contentions introduced in the Report. Why was this marvellous system concealed from the Commission, and only trotted out after there was no opportunity for cross-examination. In the first place, I have yet to learn that, because individual foreign States choose to subsidise particular interests at the cost of the community, by bounties on corn or sugar, for instance, therefore the admirable results of this system—to the corn or sugar producers—justify its adoption in England. Further, it is a little startling at the present time to be asked to introduce the principle of "government by chartered companies" into matters of education. One can scarcely conceive that a system not an undiluted success in darkened Africa and in matters of a commercial speculation is likely to be quite the best to act as a civilising influence in English education.

Again, I do not know, nor have I been told, that Danish education in general is of a superior excellence; I do know that in science, at any rate, Denmark is some distance behind, let us say, Japan. But, in reply, we are told that this Danish system of subsidising the private venture school, or as it is called, "State aid to all efficient schools alike," is the cause of the displacement of English butter by Danish, and that in consequence we are paying Denmark £12,000 a day for butter which we might make at home. If the author of that statement would have five minutes' conversation with Sir Henry Gilbert, or with my friend Professor Lloyd, he would learn (1) that the Danes learned their system of butter-making in England; (2) that as to *making* butter, the work of our University College and county council butter schools, during the last five years, has resulted in our being able to make it much better than any foreign country; and (3) that now, education —or the want of it—has nothing to do with the state of the butter market. This is proved by the fact that butter from Argentina is now capturing the market, to the disadvantage of that from Denmark. The enlightened educational system of Argentina will surely not be quoted as the reason.

The fact is that it is want of co-operation on the part of what Lord Grey calls our "intensely individualistic farmers" which is the main cause of this state of affairs. The farmers adopt the principles of the private schoolmaster (for curiously enough the members of this "depressed" industry patronises these schools more than any other), and stand out for the "free life of England." "Every man for himself, and let us swindle our neighbours," is his motto; he won't co-operate, he won't accept State-aided secondary or technical education: the result to his industry is patent to everybody.

Another point urged in favour of this Danish system of subsidising by State grants public and private schools alike, that the latter can "make as much profit as they can." Ca anyone imagine a surer way of introducing th principles of Tammany-hall into English Go vernment, central or local, than a system o allowing public men to select one or more o some 20 or 30 private schools in a given tow for grants of public money, so as to enabl the head-master to "make as much profit a he can!" Fancy 15,000 private schools eac in a position to claim "not more than £11 each (on the Danish figure) from the State, an some £84 each from the town and count councils." Of course they will all claim to ge something, for were not the 69 schools visite as "fair samples" by the Private School witnesses all found "efficient and fitted wit every modern appliance." Here we get possibility of the expenditure of £3,000,000 year before the Public Schools get a look in a all; that is to say, all the local taxation gran all the charities, and nearly a 3d. rate; trul an "incomparably more economical system than that of the Commission. But I will n press the point and admit, for the sake argument, that the system is economical— very economical to the salaries of th teachers—in fact a sweating system of th first magnitude. A few figures will prove thi With fees of from £2 8s. to £7 4s. a year, a in Denmark, the greater number being of cours nearer the lower figure than to higher, we g an average fee of about £4 5s.; the Stat grants add, we are told, half as much again t this giving here £6 10s. in all, and then the hea master "makes as much profit as he can; problem, "to find out how much the assistan masters get." Really if that "freedom which as the breath of a teacher's life" is to be pu chased at this price it will be very dear bought. It reminds one of those *recherc* works of art one sees in the windows of subu ban grocers labelled, "given away with pound of tea," and one knows at once wh quality of tea to expect; the gilt vase of fre dom can only be thrown in at the expense the quality of the educational tea. Even t pleasure of knowing that we are supporti what Dr. Rëgg, that unimpeachable authorit calls the "Free life of England," can scarce compensate our consciences for subsidisi "sweating."

One word more on the attacks upon t Commission from this quarter, and I will tu from meeting these arguments to suggesti practical conclusions. The gravest charge all I have to make against the Private Scho Association is its endeavour to introduce t

ligious difficulty into secondary education,
y comparing the position of these schools
ith voluntary elementary schools, and by
lking about State aid for secondary educa-
on as leading to "secularisation of educa-
on" (I quote their own words), "great in-
ease in crime," and "demoralisation of
uth." If any man can speak with authority
on this question, I can. The public body
ith which I am officially connected is the only
e in the country, so far, which has actually
taken over" a kind of private school. Two of
ese, one at Dorking, the other at Carshalton,
eviously managed by private companies, in
e case mainly under the control of Lord
shcombe, in the other mainly under the Rev.
W. Sharpe, have been taken over, subsi-
sed, and made efficient, with grants for
achers and apparatus; both of these schools
re previously conducted not only on a
ligious but on purely denominational basis,
d we only altered this by the introduction
a conscience clause, and by giving further
cilities for religious instruction to children of
denominations; religious instruction under
clergy goes on exactly, as heretofore,
d although the schools have children of
er denominations attending, no withdrawal
m daily religious instruction has, so far,
ken place; no less authorities than the Bishop
Southwark and the Chairman of the Can-
bury House of Laymen have given us their
proval for this action. But again, as a
nager of a Church voluntary school, and a
pporter of the extension of the voluntary
nciple, with certain safeguards, in elemen-
y education, I indignantly repudiate any
alogy between our schools and "private
fit schools." Voluntary schools are con-
cted under a managing body, and for pri-
e loss, not private profit. They earn State
nts, they are open to State inspection and
mination, their balance-sheet is public
perty, a provision so shown to the Presi-
t of the Private Schools Association, and
ir head master is not paid by profit. In
rt, the voluntary school is everything which
private school is not.

ut I will even go further and say that the
untary principle is antagonistic to private
ools. The efforts of the pious founder con-
ue to the present day, while the work of the
rporation of London and the City Companies
e extinguished private schools in large
nbers. Think of the effect upon the private
ools in the neighbourhood, of the successful
elopment of, for instance, Owen's School, Islington, under the Brewers' Company, or of the establishment of the People's Palace Day School under the Drapers' Company. Look again at table 3, page 358, of the first volume of the Report, with its list of 17 secondary schools founded by County Councils; again, a voluntary effort, for no obligation was laid upon them by the State to do anything of the sort, and they might, if they had done what was popular, have put the money into their own pockets, and into those of their wealthier constituents. What the City Companies are to London and the neighbourhood, the County Councils are to the rest of England. But I will go still further and give an instance from my own county to illustrate the extent to which voluntary effort has been called forth by municipal activity. One body of local trustees has spent over £6,000, £5,300 has been contributed by Town Councils and Local Boards in lump sums, £3,500 has been actually raised by public subscription; annual grants in addition are made by local authorities out of their own rates, which, if capitalised would produce a sum of £9,500. A total of £24,300 in five years; all voluntary efforts tending to do away with private schools. Truly, as Sir John Donnelly said in this hall, "the beer money acted as a stimulant and not as a soporific." And equally truly public control and public funds produce private liberality and do not extinguish it.

Now to turn from the past to a practical consideration of the position of these schools for the future. In the first place, most of them are not threatened at all by the report of the commission. We are told that there are 15,000 private schools. I do not propose here to question the number, though I believe it to be largely over the mark. But are those schools *secondary*? Any more glaring *suggestio falsi* than to say that any large proportion of such schools are in competition with public *secondary* schools it is impossible to conceive. In my own county, of nearly 100 schools believed to exist, three-fourths are not doing work above that of the seventh standard, and are in no sense secondary; for secondary is not a social or an administrative term, but an educational one. Of the remainder in Surrey, quite half are non-local, *i.e.*, take practically all their boys as boarders from a distance, or are socially select, *i.e.*, charge a fee of £15 or more for day boys, or both, and several are merely crammers' establishments; hence, one-eighth only are such schools as would suffer in any way by competition from a local day secondary school under a public authority. I have had a similar computation made for Manchester, which works out to practically the same figures; hence, there are only, at most, 2,000 schools in the whole of England whose existence is at stake. How many of these are efficient as places of secondary education; probably one in ten. Those proved to be even partially efficient, I would have the local authorities buy out—of course, only one or two in each place—and take over bodily, with their head master, if also efficient. He would have a guaranteed salary, capitation grants, laboratory grants, and assistance in his teaching staff; but the funds of the school should be under a body of local managers and educational experts, who would, of course, take no dividend. Schools under public companies, subject to the limitation of their dividends to the present amounts, I have always considered as practically public schools, and as such, under an amended law, open to all the advantages to be derived from public funds. I gave evidence before the Commission to this effect. But it will be noted that such schools as at present exist of this kind, viz., those of the Girls' Public Day School Company, and the Church Schools' Company are, to all intents and purposes, first grade; certainly, local authorities, besides aiding them, to a small extent, and, I believe, by means of scholarships chiefly, will want to create many third grade, and a few second grade girls' schools, which will charge a less fee than £15 a year, and will, consequently, be given large public support. So much for the local private secondary schools, about 2,000 in number.

Now for the "non-local" or expensive boarding private secondary schools. These of course will always flourish, as their existence depends upon considerations not merely educational but largely social. The example of America shows us that the increase of State-aided democratic local schools naturally drives a certain class of parent to support—in increased numbers—schools of this type, hence these have everything to gain by State-aided secondary education.

As to the majority of private schools, *i.e.*, those not secondary but primary or preparatory, and forming about 4-5ths of the whole, these also have everything to gain. Public secondary authorities will never form public preparatory schools in competition at a higher fee, and on social lines with the public elementary schools. The Commission, it is true, conceives that in rural districts, the local
authority "should not be debarred from start
ing such schools," but only on condition tha
the fees cover the whole cost of board and educa
tion. Such schools I am sure will not be starte
and if they were, as requiring no aid from publi
funds, would not compete unfairly, as it is calle
with private elementary schools. But I agre
with those witnesses, eminent head maste
and others, who consider that the head
each secondary school should give encourag
ment, advice, and assistance (as is done
St. Paul's, at Bedford, and in some other larg
day schools now, and is the case almo
universally with the great public schools) to
group of preparatory private schools in t
neighbourhood. He can make these efficie
on the one hand, and see that they do not t
to become secondary on the other. Th
position will be immensely strengthened
such support, and every local first gra
school almost entirely, and every local seco
grade school partially, will thus tap a stratu
of private schools from which a copio
supply of properly trained children will fl
into its classes. Our complex civilisation a
our conditions of society demand (howev
wrong it may be theoretically) that the
should be other primary schools besides tho
known as public elementary. Hence priva
schools, *if efficient*, whether taken over, reco
nised, or quite independent, have all to ga
from the report of the Commission.

Just a few words, in conclusion, as to t
prospects of speedy legislation on the lines
the report. We are told that Sir John Gorst
drafting his Bill, and I partly believe it. T
elementary school difficulty should be t
secondary school opportunity. Legislation
stricting elementary authorities and th
schools from exceeding their legal powe
must have as a supplement legislation ma
ing it unnecessary for this trespass in t
future by creating other authorities to occu
the ground. But if we are to have leg
lation, it will demand that all in fav
of the broad principle sink their mi
differences and leave opposition to come fr
the vested interests only. The farmers wh
motto is now, "Dig we cannot, to beg we a
not ashamed;" the eminent Q.C.'s, feari
that, with a further spread of education, they w
find their occupation gone, will no doubt do wh
they can to perpetuate that educational cha
upon which they have so far flourished. Her
if the Cambridge conference is not to result
a *réchauffé* of the irresponsible frivolity wh
characterised the conference at Oxford, a

hich is so absent from the Report of the ommission, the reasonable men of all parties ust unite upon a platform with a single ank, namely, *Public Secondary* Schools. It hoves teachers especially to recognise that eir interests, so strong on the Commission, iich gave due prominence to professional estions, are practically not represented in e House of Commons, and that attempts at mending" the report from that quarter will ore likely result in "ending" it. The safest licy, and the only possible one, for believers the good old English principle of com- omise, so fully carried out by the Commis- n, is to vote for "the Report, the whole port, and nothing but the report."

DISCUSSION.

Mr. J. EASTERBROOK said there were so many nts dealt with in the paper, that it would be ossible to touch upon many of them, and there s a certain cocksureness about Mr. Macan's utter- es which, to a great extent, carried conviction. At t he thought that the primary school in the diagram s meant to be the same as the public elementary ool, but he afterwards corrected that opinion to a ain extent; and he quite agreed with Mr. Macan t all young children could not be sent to public nentary schools, as some people seemed to think. England the condition of society was such that re would always be a demand for preparatory ools, and, he believed, that up to the age of nine en, even boys were best taught by ladies. In the gram the scholarship ladder appeared to go from it he took to be the private preparatory school, which was probably meant to include public nentary schools; and it joined the secondary ool at the bottom, but, as a fact, it did not join at bottom. He believed, in the case of any scholar- s given by public bodies in secondary schools, it ed somewhere about the middle. In his own , he found that boys who came with scholarships e best put in a remove form, where they were cially taught in certain subjects, until they could the general curriculum of the secondary school. ain, he thought Mr. Macan had slightly mis- erstood the intermediate scholarships granted by Technical Education Board. They were not in- led, primarily, to take boys from the top of the er grade school to the middle of the secondary ol, but rather to prolong the education of a for another year, who without it would not stayed so long, and afterwards to take on, if he desired, to a technical college. His idea of a higher grade school was this. He ght it was a legitimate ambition on the part of School Board to try to do something more for their scholars than simply pass them through the standards. There were always some boys in the elementary schools of exceptional ability, who should be passed on to a secondary school by scholarships, but there would be others whose education could be continued with advantage to themselves and the community beyond the standard. He would take them beyond the Sixth Standard, and place them in a day continuation school, which was a higher grade school of another kind—a trade or handicraft school—where he would carry on their general education and give them a sound elementary science education and a good deal of manual work. If a higher grade school did more than that, and tried to teach French, German, and Latin, it was really a secondary school.

Sir PHILIP MAGNUS said he did not profess to have read the whole of the report and evidence of the Commission, but he had endeavoured to understand the recommendations. It was very gratifying to hear such a paper, displaying an enthusiasm which was rare. In the earlier part Mr. Macan enunciated some very sound educational principles which indicated the grave difficulty which had to be faced by anyone who attempted to plan out a system of graded education. It was quite impossible to arrange any system of public schools in which each one of the series should be preparatory to the one above it. No successful attempt of that kind had been made, except in the very highest schools of all, and for this reason. As had been pointed out the curriculum of every school must be determined by the age at which the pupil left. Those who dealt with the highest education knew that it was intended to prepare for the universities, and hence every school in the series led up to the university and was, correctly speaking, a preparatory school. Beginning with the nursery, preparation was made for the preparatory school, that was a preparation for the higher school, and so on right up to the university. Each school in the series had for its object, not to equip the boy in the best possible manner when he left, but to equip him for passing into the next school above. A straight line could not be drawn through any other series of schools. The great majority, on leaving the elementary school, had to go direct to work, and hence the education must be of a terminal character. The governing idea must be, not to prepare the boy for higher education but to fit him for the work he had to do when he left. True, some exceptional boys should be taken from that school into another, but they must be regarded as exceptional, and their education must not interfere with the general curriculum. All would admit that it was desirable to do what they could to facilitate legislation, because some system of organisation for secondary education was absolutely necessary; but he doubted whether the appointment of a Royal Commission was the best means of attaining the end some of them had in view. When a Government found there was a great popular demand for some organic change or new departure, as shown by public speakers and the press, it appointed a Royal Commission. For sometime at least that gave free play to energies which might otherwise have been troublesome, and after a couple of years had been expended in investigation, a pile of books was published, such as they saw on the table. After that, meetings were held like the present, and like the conference which was to be held at Cambridge, at which very divergent opinions were expressed, and then the Government felt satisfied that it would be able to beat a safe retreat behind the differences of opinion which were expressed. His fear was that under the circumstances this very able paper would not conduce to a solution of the problem.

Mrs. PILLOW said she was strongly of opinion, from what had occurred at Norwich, that higher grade schools should be placed in a totally different category from secondary schools. There, two large, higher grade schools had been established, one for boys, and one for girls. It was a sort of social distinction to send children to them, and instead of their being attended by children who had done well in the elementary schools, they found people with £300 and £400 a year sending their children there, and people in the country sent their children in gigs and waggonettes, and they got an education worth £10 a year, or more, for 30s., books included. That kind of thing ought not to exist under the School Board system. The King Edward VI. school in the city had become practically empty until recently a reaction had set in through articles appearing in the newspapers and the Secondary Education Report, and the boys had been gradually leaving the higher grade school and going to the Edward VI. school. There was no school to which girls could go, however, except the high school in Norwich, but that was full, and there was nothing between it and the higher grade school. The probability was that another higher grade school for girls would be built at the expense of the ratepayers, to which many girls would go who ought to attend secondary schools.

Mr. HILL thought Mr. Macan had put forward in the main, in a very clear and intelligible form, views which most of those interested in the matter would assent to. It was most undesirable that the power of levying a rate should be granted to the new Boards. On the other hand he rather deprecated the attack which had been made on private schools, and he should much regret if a very large number of schools were excluded from any new system of secondary education. When in America he had been much struck by seeing the enormous number of advertisements of private schools. It was considered the proper thing, especially with girls, not to send them to public schools but to private establishments, where he understood the education was frequently of a very imperfect character, but the chief thing aimed at was to give the pupils a kind of social polish. He was afraid that in England a
the time would never come when they could p
vent people who could pay for it choosing
schoolmaster or mistress and getting the educat
they required, and if these schools were fr
from all legal control, excepting sanitary insp
tion, it would be a serious thing. If possi
every school should be under the law, and for t
reason he thought a register, if formed, should in
first instance be exceedingly wide, and he wo
rather insert a number of people only imperfe
qualified, than leave a large number out altoget
He believed the number of private schools was e
mously exaggerated. Taking Kelly's "Director
the County of Berks," which had a populatio
162,000, excluding Reading, there were public
private secondary schools to the number of 76, a
large majority of these were girls' schools. In fu
that was where the difficulty would arise, and u
they took care, the idea would gain ground
girls of the higher middle class need not be
educated, so long as they had a certain amou
social polish. He did not think private schoolma
as a rule were well paid; in many cases he knew
had a hard struggle, and it was by no means a
thing for a man to make a large income out
private school.

The CHAIRMAN, in proposing a vote of than
Mr. Macan, said his paper was like the beer mon
"more of a stimulant than a soporific." Educa
like everything else, was much affected by colla
considerations, and in this case the difficulty wa
a great extent a social one. People who talked a
education sometimes forgot that England was f
social prejudices, which would have to be taken
account, at all events for the next generation or
Though the social millennium might be coming, i
only making progress very gradually. It was
possible to make English people send their chi
to the public elementary school; and it app
that, even in democratic America, there was a
against it. The girls, especially, were not sent t
but to private schools, mainly for social reasons.
gentlemen he occasionally met, in connection
the question of education, seemed to him partic
thoughtful about these conditions; many t
artlessly suggested as improvements created th
pression that you were a prejudiced aristocra
that you had some design on the social positi
the people, though you were unconscious of any
of the sort; and sometimes he found jealousie
suspicions of that nature in the minds of p
whom he would hardly have suspected of it.
Macan said that, in many small places, they
be inclined not to impose a rate, and would be
to have the beer money in relief of the
Probably that might be true, if you appealed
very small area; but as the House of Parlia
as a whole, was wiser than any individual me
so the larger the area you appealed to the less

t were they to these prejudices. The County uncils, on the whole, had done very well: only ee now stood out on the question of the beer mey, and probably they would come round in a le time. It must be remembered that agriculists were in a very parlous state; they had to pay hes and rates in respect of land which was tirely unproductive, and you could not wonder their readiness to get money from any source to et those charges. Gloucestershire was an agritural county, and the temptations and difficulties men in distress were very great. At the same e, they should endeavour to teach people there l elsewhere that the true remedy lay in more ication, and that it was not to their real interest to rve the schools; and apply this money in relief of rates. He was a Welshman, and came from a ntry which, in some respects, was a little in ance in matters of education; and no doubt the ort of the Royal Commission, in some respects, lowed the lines of the Welsh Intermediate Educan Act. Mr. Acland, who was a neighbour of his Carnarvonshire, had a great deal to do with ming the first scheme, and he had had an opporuity of seeing the development of some of these emes. The Welsh county councils were composed representatives of the various localities, and they ne to the county town to legislate for the whole nty; but it struck him that they approached the icational problem in a frame of mind not at all icational. The man from a town at the other end the county did not look on the *locale* of a scheme m an educational point of view; he said to himself, e is money going, and I must have some of it nt in my own town; and the result had been that Carnarvonshire secondary schools had been estabied far in excess of any possible demand; they uld probably compete with one another, and ure each other's efficiency. He suspected that ilar difficulties would arise in England later on. . Macan evidently thought there was something ten in the State of Denmark; he did not know ch about that country, but from what he could ertain he thought Mr. Macan's facts were mainly rect. It must be remembered, however, when aking of the rate of pay, that the expense of ng in Denmark was very low; a man with £300 a r was quite wealthy; and an assistant-master with o a year would probably be much better off than with two or three times that amount in London. thought a Royal Commission was a useful means bringing out facts; it popularised questions, and ught the public to see the necessity of matters ich they never would see unless they were forced on their notice in this way. The admirable digest this report, which appeared in the National ciety's journal, had spared him a great deal of uble, from that he went to the report itself, and m time to time he had looked into the evidence, t whether he should ever read it all he could not . This paper would certainly do a great deal to educate the country upon the question, and he hoped it would have some influence in solving the problem in the fashion which generally prevailed in England, by a judicious compromise.

The vote of thanks having been carried unanimously,

Mr. MACAN, in reply, said his criticisms on the rate of pay in Denmark were quoted from a pamphlet published in hostility to the Report of the Royal Commission, and designed to show that this system was suitable for England. The factor of the lower standard of living would not modify those conclusions if the same system were introduced into England, where the population was so much greater, and the standard of living higher. Mr. Easterbrook had not quite understood the scope of the diagram, which was only of a general character, and not meant to show all the details, which would have been impossible. The place in the secondary school where the scholarships entered was opposite the age 13, and was not intended to be the bottom; he could not in a diagram deal with anything below that. He quite agreed with Mrs. Pillow that the higher grade schools at the present existing were doing the wrong thing; they were providing a kind of educational margarine in imitation of the secondary education butter. What was wanted was a higher grade school, which should perform an entirely separate function; a school which should be only for handicrafts, leading directly on from the primary school and not connected with the secondary system. The portion of the Report dealing with intermediate scholarships was very obscure, but he agreed that it was not the function of an intermediate scholarship to lead up to secondary education, unless in exceptional cases, but rather to form part of it.

General Notes.

BUDAPEST EXHIBITION, 1896.—Information has been received by the Department of Science and Art, through the Foreign Office, from the Austro-Hungarian Ambassador at the Court of St. James's, announcing a national exhibition, under the patronage of His Imperial and Royal Apostolic Majesty, will be held at Budapest this year, which will be coincident with the 1,000th anniversary of Hungary. The exhibition will be opened on 2nd May next.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 26.—"The Standard of Musical Pitch." By A. J. HIPKINS. SIR ALEXANDER C. MACKENZIE, Mus.Doc., will preside.

MARCH 4.—"Röntgen's Photography of the Invisible." By A. A. CAMPBELL SWINTON. PROF. JAMES DEWAR, M.A., F.R.S., will preside.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock :—

FEBRUARY 27, at 4.30.—"The Tobacco Industry of India and the Far East." By C. TRIPP, formerly of Sumatra. THE MARQUIS OF LORNE, K.T., M.P., will preside.

*** This Meeting will be held at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

FEBRUARY 25.—"The Palette of the Potter." By WILLIAM BURTON, F.C.S. WALTER CRANE, R.I., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c." Three Lectures.

FEBRUARY 24.—LECTURE II.—Chemical relations of the selected metals to some non-metals and to each other—Compounds of iron—Oxides—Ferrous and ferric condition—Ferrous carbonate—Oxidation of ferrous compounds—Action of Acids—Copper compounds—Oxides and hydrates—Chlorides and oxychlorides—Acetate and carbonate—Changes produced on copper compounds—Superficial coating of green compounds on copper.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 24 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. M. Thompson, "The Chemistry of Certain Metals and Their Compounds used in Building, and the Changes Produced in Them by Air, Moisture, and Noxious Gases, &c." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Dr. Macadam, Report of Committee on Dr. Dawson Turner's paper on the "New Method of Photography." 2. Mr. E. Monkhouse, "The Distribution of Electricity in Edinburgh."

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. A. C. Kent, "The Lighthouses of the British Isles."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Rev. F. C. Lambert, "The First Principles of Pictorial Photography." (Lecture II.)

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Sir John Lubbock, "Swiss Scenery."

TUESDAY, FEB. 25 ... SOCIETY OF ARTS, John-stre
Adelphi, W.C., 8 p.m. (Applied Art Sectio
Mr. William Burton, "The Palette of the Potte

Royal Institution, Albemarle-street, W., 3 p.
Prof. Charles Stewart, "The External Coveri
of Plants and Animals: its Structure and Fu
tions." (Lecture VII.)

Medical and Chirurgical, 20, Hanover-square,
8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.

Photographic, 50, Great Russell-street, W.C., 8 p.
1. Mr. F. E. Ives, "The Stereoscopic Photochi
moscope." 2. Mr. T. E. Freshwater, "Mess
Newton's Simple Method of Projecting Ster
scopic Pictures." 3. Mr. J. Lunt, "Stellar Pho
graphs taken without a Driving Clock."

Colonial Institute, Whitehall-rooms, Whiteha
place, S.W., 8 p.m. Mr. J. G. Maydon, "Nata

WEDNESDAY, FEB. 26...SOCIETY OF ARTS, John-stre
Adelphi, W.C., 8 p.m. Mr. A. J. Hipkins, "
Standard of Musical Pitch."

Geological, Burlington-house, W., 8 p.m. 1.
C. W. Andrews, "The Structure of the Ples
saurian Skull." 2. Mr. Alfred Harker, "Cert
Granophyres, Modified by the Incorporation
Gabbro Fragments, in Strath (Skye)." 3. P
Edward Hull, "Observations on the Geology
the Valley of the Nile, and on the Evidence of
Greater Volume of the River at a former Perio
4. Mr. F. R. Cowper Reed, "The Fauna of
Keisley Limestone.—Part I."

Royal Society of Literature, 20, Hanover-squa
W., 8 p.m.

British Astronomical, University College, Gow
street, W.C., 5 p.m.

THURSDAY, FEB. 27...SOCIETY OF ARTS, John-str
Adelphi, W.C., 4½ p.m. (Indian Section.)
C. Tripp (formerly of Sumatra), "The Toba
Industry of India and the Far East." (This me
ing will be held at the Imperial Institute, So
Kensington.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6
Rev. Canon Benham, "Rambles through
Churches."

Royal Institution, Albemarle-street, W., 3
Prof. H. Marshall Ward, "Some Aspects
Modern Botany." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.
8 p.m. 1. Discussion on Mr. F. Bathurst's Pa
"The Electric Mining Question." 2. Discus
on Mr. Sam. Mavor's Paper, "Concentric Wiri
3. Mr. G. L. Addenbrooke, "High Voltage La
and their Influence on Central Station Practice

Civil and Mechanical Engineers, 45, Charing-cr
S.W., 7 p.m. Mr. A. S. E. Ackermann, "Tes
Materials of Construction."

Camera Club, Charing-cross-road, W.C., 8¼
Mr. Hoddinott, "Three Winters in the Alps."

FRIDAY, FEB. 28...Society of Women Journalists (at
HOUSE OF THE SOCIETY OF ARTS), 8 p.m.
Welldon, "Journalism as an Educational Fact

Royal Institution, Albemarle-street, W., 8
Weekly Meeting, 9 p.m. Dr. John Mur
"Marine Organisms and their Condition of
vironment."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.
5 p.m. 1. Sir D. Salomons, "Experiments
Incandescent Lamps." 2. Messrs. Fleming
Petard, "The Alternating Current Arc."

SATURDAY, FEB. 29...Royal Institution, Albemarle-st
W., 3 p.m. Lord Rayleigh, "Light." (Lecture

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ALBERT MEDAL.

The Council of the Society attended at arlborough - house, on Wednesday, 26th nst., when His Royal Highness, the Prince f Wales, K.G., President of the Society, resented to Sir Lowthian Bell, Bart., F.R.S., e Albert Medal "in recognition of the serices he has rendered to Arts, Manufactures, nd Commerce by his metallurgical researches d the resulting development of the iron and eel industries."

The members of Council present were—ajor-General Sir John Donnelly, K.C.B., hairman); J. Wolfe Barry, C.B., F.R.S.; ord Belhaven and Stenton; Major-General r Owen Tudor Burne, K.C.S.I., C.I.E.; ichael Carteighe; R. Brudenell Carter, .R.C.S.; Sir George Hayter Chubb; Prof. ement Le Neve Foster, D.Sc., F.R.S.; The on. Sir Charles Fremantle, K.C.B.; Sir ouglas Galton, K.C.B., D.C.L., F.R.S.; Sir illiers Lister, K.C.M.G.; Sir Westby Perval, K.C.M.G.; Sir Saul Samuel, K.C.M.G., B.; with Henry B. Wheatley, Assistant-cretary of the Society.

R. HARRIS'S CANTOR LECTURES.

In consequence of the pressure of unforeen business, Mr. H. Graham Harris finds nself quite unable to deliver the course Cantor Lectures on "Refrigeration," nounced for delivery on March 9, 16, and . These lectures are therefore unavoidably stponed until next session.

ROFESSOR THOMSON'S CANTOR LECTURES.

ROFESSOR J. M. THOMSON, F.R.S.E., ivered on Monday evening, 24th inst., the second lecture of his course on "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c."

The lectures will be published in the *Journal* during the summer recess.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 25, 1896; WALTER CRANE, R.I., in the chair.

The CHAIRMAN, in introducing Mr. Burton, said that though he was a manufacturer he was not one of those who thought simply of making profit, but desired also to produce things of beauty, and called to his aid artists of distinction; at the same time he left no stone unturned to perfect the processes by which tiles and other beautiful works of art were produced.

The paper read was—

THE PALETTE OF THE POTTER.

By WILLIAM BURTON, F.C.S.

It is customary to speak of the "Palette of the Potter" as if it were a very limited and uncertain one; and of the purifying fire to which his colours must of necessity be subjected, and which should render them everlasting, as if it prevented absolutely the production of those effects which depend on certainty of results. The potter is certainly debarred from the use of many colours and colour processes which are used in other crafts, for instance, he cannot make any use of those brilliant but often transitory aniline colours that have been the chemist's most striking gift to the painter; but that may be gain rather than loss. The fact that in many of his processes the colour flows and softens somewhat in the fire, certainly prevents him from obtaining, by some of his processes, those artistic effects which depend on sureness of line, or certain, delicate gradation of tint; but, on the other hand, his materials and processes carry with them many and great advantages, which make one wish they were oftener used with a single eye to the best that could be done in them, instead of being wasted in fruitless endeavours to obtain effects proper to other processes. Pottery colour, at its best, seen under a transparent glaze, or in combination with that glaze, has a rich, juicy quality that is all its own, recalling the hues of pebbles under water, or the softness and mystery of polished jasper or onyx; it becomes, in fact, precious and jewel-like, and with the great added advantage that it is among the most imperishable and lasting of man's productions. Even in its simplest form of the natural unglazed colours of baked earth, the slip-painted vases of many Eastern nations suffice to show how completely the potter's palette may meet all the requirements of right decorative work, while the splendour of the glazed work of the Persian potter, or the Italian majolica painter, prove its suitability for colour schemes of the most powerful and brilliant kind. An examination of the productions of the modern potter shows that far from being limited, he has more colours and processes at his disposal than are altogether for the good of his art, and would probably do far better and more satisfactory work, were his means more limited than they really are. Instead of condoling with the potter on account of his hardships, it would be better to demand of him simpler and more genuine effects; effects which flow naturally from his materials and processes, which, by their restraining limitations should keep him artistically in the paths of sobriety and rectitude.

A piece of pottery, even of the commonest kind, is seldom a simple thing. It consists, primarily, of a clay base known as the *body*, which may itself be coloured, either naturally or artificially; over this, for beauty no less than for use, there is frequently a coating of glass, known as the *glaze*, which again may be coloured throughout its substance, or may serve as a protective covering for a layer of colour painted on the body, or may have other colour painted upon its surface and fused into it. We may have, therefore, colours in the clay or body; colours dissolved in the glaze; colours put on the body and under the glaze; colours fired on to the glaze after it has been itself fixed; or, finally, a frequent device of the modern manufacturer, two or more of these methods may be used in combination, to produce the final result. One fundamental point connecting all the colours used by the potter —no matter how they are applied—is the necessity of firing them. Nothing can be considered pottery colour which has not been fastened on to or into the ware by exposure to at least a red-heat; and though the peoples of Eastern Asia, the Turkish potters, and many others, use unfired colours and varnishes in decorating their productions, such can never be regarded as belonging to the realm of true ceramics at all.

Grouping all known pottery colours and colour methods (whether of the ancient potter or the modern) together, they fall under five or six heads, and, for simple illustration of the various groups, they may be arranged in tabular form, with the commonest and highest types of each class put opposite for reference, thus:—

Colour Classes.		Common Type.	Highest Type.
1. Body colours	(*a*) Natural clay colours.	Red and buff bricks	Greek painted vases
	(*b*) Artificial clay colours	Blue and green floor tiles	Wedgwood's Jasper Solon's Pâte sur Pâte
2. Underglaze colours		Modern printed dinner plates..	Persian Pottery Italian Majolica
3. On-glaze colours		Modern painted chinaware....	Vieux Sèvres
4. Lustres..........................			
5. Coloured glazes		Green glazed pottery	Modern English Majolica (so-called)
6. Combinations of the foregoing........			

The actual colouring substances used in all these processes have a common origin; they are of necessity derived from inorganic or mineral sources; for no substance of vege table, or other organic origin, can endur without decomposition even the lowest hea at which pottery colours have to be fired. Beyond this, further limitations are imposed, by the fact that many mineral substances of brilliant colour, which have been long known and extensively used by the painter of fresco or canvas, such as vermilion, orpiment, or ultramarine, are equally incapable of enduring such a temperature, and are consequently valueless to the potter; so that, finally, the list of compounds which can be used as colour bases is reduced to half a dozen simple metallic oxides, and about an equal number of compound oxides or salts, such as chromate of iron, or the little understood "purple of Cassius." Some of the substances, such as the oxides of iron and copper, have been known and used from the earliest times; others of them, such as oxide of chromium and chromate of iron, have been introduced into the potter's palette within the last hundred years or so.

The simplest and most natural starting point from which to commence a study of the potter's colours is, beginning with the colours of natural clays, to follow the order given in the Table above, which is not only the simplest possible arrangement, but which marks out for us also the successive steps by which the potter's palette has been developed historically.

Natural Clay Colours.—Clay being the material from which all pottery must be made, so soon as men discovered that clay vessels could be hardened by fire—really made into pottery—they must also have been struck with the further fact, that during the firing, clay not only shrinks and becomes hard, but that it also changes colour. Few clays occur naturally in anything like a state of chemical purity; even the finest potter's clay contains traces, and often more than traces, of Nature's great colouring agent, oxide of iron; and whatever the *natural* colour of any particular clay may be when it is dug out of the earth, its colour, when fired, will depend to a great extent on the amount of oxide of iron it contains. The chemical or physical conditions in which the oxide of iron actually exists in the clay, and the presence or absence of certain other substances modify the tint to some extent, but for our present purpose it will be sufficient to assume that the colour a clay will assume in burning depends mainly on the proportion of oxide of iron it contains. The typical burnt clay colour given by a full proportion of oxide of iron, is red—the red of a good Ruabon brick—and as the proportion of oxide of iron diminishes, the colour becomes paler, passing through various shades of lighter red, salmon, fawn, and buff, down to pale grey—the grey of stoneware. It is important to bear in mind that in most of these varied tints we are dealing not merely with the same colouring matter, but with the same colour, which is stronger or weaker as it is mixed with different proportions of the clay stuff itself, which in a state of absolute purity would be a greyish-white. No other colouring substance is so generally associated with clay as to furnish any effective pottery colour of more than local importance; which is another reason why clay colours should be considered first, as we may say with substantial accuracy that all natural clay colours belong to one simple chord, being derived from one and the same colouring substance.

The colours of this class are uniformly dull and quiet, for they all belong to the dullest end of the chromatic scale, and their surface sheen being merely that of fired clay, they possess neither brilliance nor lustre; yet that such colours, low and quiet in tone as they are, can be of admirable decorative service is shewn unsurpassably by the painted vases of the Greeks, in which the colours almost invariably belong to this class alone. From the very nature of its formation, the pottery of every country and of every age has owed much of its colour to the variety and bounty of Nature in colouring her clays; the potters of every land find such colours sufficient for their everyday requirements, and from the cheerful red brick or tile floor, to the simple red or yellow porringer or platter, Nature alone supplies all our requirements.

When a coating of clear glass is applied to pottery, it is found that all these natural clay colours are more or less modified by its action. To what extent and in what direction they will be modified depends greatly on the nature of the glaze, and the amount of heat needed to melt it, but it will be found, generally, that all the paler shades of clay colour, such as grey and buff, are purified and brightened by a glaze being melted over them, while the stronger colours, the various shades of red, are darkened, sometimes to such an extent that a clear, bright red, may pass into a dull, dark chocolate colour. Some few clay colours acquire a softer delicacy of hue, or become almost as bright as the painted colours to be considered presently. There is a well known salmon-coloured body, largely made in some parts of India, Persia, and Syria, and commonly decorated with spots of enamel, white, and turquoise, that assumes a soft and delicate bloom when glazed, very different from its quality without the glaze. Most striking of all clay colours, in this respect, is that well known red used in decorating the so-called Rhodian pottery, which is a native clay material, exceptionally rich in oxide of iron, burning of itself to a dull, earthy colour, but becoming, when glazed with the thin alkaline glazes used by those potters, in spite of the opacity due to its earthy nature, one of the most brilliant and powerful colours ever used on pottery.

In process of time, potters naturally began to experiment with their clay materials, and proceeded to dye their clay—if we may use such an expression—by adding to it some of those brilliant and powerful pigments that had become so valuable to the painter and the glass maker. They had found how easily the natural clay colours could be modified, by mixing one that burnt of a dark red colour with one that burnt yellow, and so they passed quite beyond the scheme of the iron colours, and by the introduction of varying proportions of oxide of cobalt, or oxide of manganese, they obtained shades of blue, green, slate colour, brown, and black, which enabled them to complete their palette in this direction. These advances are all of modern date, for it seems almost certain that the famous Josiah Wedgwood was the great pioneer in this direction. His well known jasper wares, with the white bas-reliefs on blue, green, yellow, and black grounds, are certainly the most striking instances of this kind of pottery colour, which has since his time been brought into such extensive use by Hollins, Minton, and Co., and the other great tile makers, in the production of their green and blue pavement tiles, and particularly in their elaborate encaustic tiles, in which clays of various colours, either natural or artificial, are inlaid in geometrical and conventional patterns.

We have assumed hitherto that the final colour result obtained, is dependent on the amount of colouring matter used in the clay, but we must briefly consider now a number of accidental effects, often of the highest artistic value, which arise from many apparently simple and trivial circumstances connected either with the preparation of the clay, the processes of manufacture, or the uncertainty of the firing to which the articles are subjected. It will be found, finally, that with all clay colours, the ultimate tint produced will be influenced, to a slight extent, by the process of making and the kind of surface obtained; that it will be influenced, to a greater extent, by the conditions of relative dryness or dampness of the article when it is placed in the oven to be fired; and that, probably, most of all, it will be influenced by the kind of atmosphere obtained inside the oven during the firing process itself. It is always found, for instance, that bodies which are of a more vitreous nature, or that are finer in texture, and consequently finish to a smoother surface, will be more brilliant in colour, than those which are of a coarser texture or are of a less vitrifiable nature. This simple fact has been known and acted upon for a very long time. The Greek and Roman potters in order to obtain a brilliant colour on the surface of their red pottery, frequently finished it with a thin coating of slip, of the same clay that the vessel itself was formed, but refined and made more vitreous, by washing and sifting it and using only the fine clayey portions freed from sand and grit. Similarly, the finest artificial clay colours only develop any considerable brilliance of hue, when they are added to clay bodies, which partially fuse or vitrify in the fire, and approach so far toward the nature of glass, as actually to dissolve some of the colouring matter. This is the distinguishing feature of Wedgwood's jasper bodies, the component materials of which unite together to form a clay mass that is translucent in thin pieces after firing, and as light will consequently penetrate slightly below the surface the colour becomes much brighter than it would be in a clay body of ordinary composition. The most striking effects due to this translucence of the body are found, however, in the Pâte-sur-Pâte pottery, which Solon, by improving and extending methods first used at Sèvres, has brought to such perfection for Messrs. Minton. Here the clay material is mixed with a large proportion o ground felspar, so that when fired the mass vitrifies and becomes remarkably translucent and when the effect is still further enhanced by a coating of transparent glaze, the colours which are incorporated with the clay materia become glowing and luscious, and are as fa removed from ordinary clay colours as a slab of polished onyx is from unpolished marble.

Effects of this kind are of course as much under the control of the potter as the production of a pot itself, but the effects of damp and of firing are most uncertain. Clays vary exceedingly in the tenacity with which they retain the moisture needed to keep them sof enough for working, and this characteristic introduces an element of uncertainty which may at times quite upset the potter's calculations, even while it lends a charm and variety admirable in themselves. The influence of moisture, so far as its effects on clay colours are concerned, is fortunately always in one direction; whatever the particular colour may be, a piece of moist clay will always burn of a darker colour than a corresponding piece of absolutely dry clay; and frequently the effects of moisture go further than this, causing the colour to be aggregated in spots and patches, with the production of delightfully varied and broken colour. It is quite possible that the lovely mottling of brown colour on the surface of many grey stonewares may arise in part from even so simple and accidental a cause as this.

Finally, we come to the effects of the fire, and particularly to the effects produced by the kind of atmosphere surrounding the pottery while it is in the oven during the firing. One of the commonest results in a manufactory where coloured bodies are largely produced is the appearance of streaks or patches of darker colour on the ware after firing. Buff articles will come out streaked with red, red may be changed to chocolate, or to a purplish black, and even the aggressive blue of Wedgwood's jasper may be found at times subdued to a deeper tone, more nearly rivalling the fine qualities of Prussian blue. There are dozens of Greek vases in the British Museum, and in every extensive collection, where the figures that should have been red, and were left in bright red by the vase painter, have been urned wholly or in part to a dark purplish colour, often with great resultant charm. All hese variations, with others of a similar kind, are due to the variations, not so much of the actual temperature, as of the atmosphere produced by the firing, and which must circulate round and about the articles inside the oven, mperfectly screened as they are from the smoke and other products of combustion. If he fires are allowed to burn rapidly and clearly, with free access of air, then the atmosphere inside the oven will probably be an oxidising one, and the colours produced will have the utmost brilliance possible to them; f, on the contrary, the fires burn slowly, with estricted allowance of air, and with production of smoke, then the atmosphere inside the oven will be more or less reducing in its haracter, and the various colouring oxides, osing a portion of their oxygen, will suffer uch changes as have been indicated. The most extreme instance of the kind under consideration is shown in the production of the Staffordshire blue bricks and roofing tiles. In this case, a clay that would in the ordinary course burn to a full red colour, is fired in such a way that dense volumes of black smoke are turned into the oven during the last hour or two of firing, with the result that the red oxide of iron in the clay is deprived of part of its oxygen, and is converted into another oxide of iron, the magnetic oxide, which is of a purplish black colour.

In the use of clay colours we find no positive break between ancient and modern work; the natural clay colours, red and buff, are as extensively used now as ever they were; a few new colours have been discovered, and that is all: but in the next great group, the *underglaze colours*, the case is entirely different.

All underglaze colours, of whatever period, must of course be derived from mineral sources, but they have no real or generic relationship to clay, being, in fact, closely allied to some of the pigments used by painters, and still more closely to the pigments used for colouring the glassmaker's pot metal. It is only to be expected, therefore, as the potter's knowledge grew and spread, as the art of glazing and painting pottery was carried into other lands, from Persia to England, that alterations and modifications of underglaze colours and processes should be made, according to the materials that came most readily to hand in each country. The continuity of natural clay colours is assured from the necessity of using clay to manufacture pottery at all, but a glaze is always an artificial substance; and every change in the composition or nature of the glaze has been accompanied by changes in the underglaze palette. The tendency has been, of course, for glazes to be multiplied, and for underglaze colours to become more elaborate in mixture, and more complicated in their effects; so that it becomes necessary, in dealing with this portion of the subject, to commence our study of the underglaze palette in its simplest form, and then pass rapidly in review, the successive changes that have been made in it.

Regarding the method of applying underglaze colours, we may remark, in passing, that they are generally applied to the pottery after it has been once fired, though this is not an essential or invariable rule, being devised to meet the requirements of manufacture rather than the needs of art; one or two points tell in its favour, however—first, a piece of fired pottery is much more readily and safely handled by the painter, after it has been fired, than when it is in the clay state; and, second, as the heat needed to fuse the glaze is generally less than that needed to convert a piece of clay into a solid and durable pot, the method of colouring the pottery after it has been once fired, saves the colours from being exposed to a fire angrier than need be, and the palette is extended by several colours that will endure the glazing heat, while they would be decomposed by exposure to the higher temperature of first firing. This is strikingly shown by the difference between the underglaze palette used for earthenware, where the glazing fire is not so intense as the first or "biscuit" fire; and that of true porcelain, where the glazing fire is much more intense than the first fire.

The introduction of a glaze, or coating of glass on pottery, may, with perhaps the balance of probability, be ascribed to the people inhabiting the lands round the eastern end of the Mediterranean Sea, and certainly the earliest underglaze painting seems to have been done on the pottery which, for want of a better name, is commonly spoken of as Persian. The earliest glaze would be a simple glass, then, as now made by melting together by fire certain proportions of sand or other siliceous material with potash or soda; such a glaze we therefore describe as an *alkaline glaze*. Glazes of this kind do not readily adhere to the surface of pottery made from a plastic clay; there is a want of chemical and physical fitness between the two things, and the early glaze makers must have been sorely troubled by the bubbling, scaling, and chipping that the glaze is liable to in such cases. This difficulty was, however, overcome by mixing the clay with a large proportion of sand, a process which has the defect of diminishing the plasticity of the clay, so that finally, and for many centuries, it was the custom to shape the articles in ordinary plastic clay, which was then coated, on the face to be glazed, with a slip composed of a small proportion of fine clay mixed with a good deal of ground sand. This siliceous slip coating served several purposes; it hid the natural red or buff colour of the clay from which the pottery was made; it enabled the alkaline glaze to adhere perfectly without annoying bubbles, scalings, and other disfigurements; and, farther, it furnished a light background on which the painted colour could assert its brilliance. Pottery treated in this way, with plenty of free silica in the body, or with a siliceous slip coating, and glazed with an alkaline glaze, is the best medium for underglaze colour work that has ever been invented; and whether in the hands of the Oriental potters, of Deck in France, or of De Morgan in England, quite manifests its superiority over the other bodies and glazes in more general use. One main reason of this superiority lies in the perfect translucence and limpidity of the glaze; while, perhaps, a still more powerful reason is, that certain underglaze colours, intrinsically of great beauty, such as the turquoise from copper, the violet from manganese, and the Rhodian red which has been already mentioned, cannot be obtained to perfection under any other glaze than an alkaline one.

The famous blue-green colour known as turquoise, and obtained by fusing oxide of copper with a vitreous preparation rich in soda, was well known to the ancient Egyptians, and this may have been the first colour used as an underglaze pigment. But at a very early period oxide of cobalt, at all times and in every country the great resource of the potter for his pure blues, was found in use along with this turquoise; and if we add to these two the green colours produced by oxide of copper when it is not specially prepared for turquoise, we have the three colours that form the staple palette of all the potters whose work is indiscriminately described as Persian. The great charm of all this pottery lies in the purity and glowing depth of these simple colours, in the skilful combinations and contrasts obtained, and in cunningly devised variety in the individual colours themselves. A great deal of this variety of colour was doubtless more or less accidental; and much of it was due to the uncertain composition of the mineral earths and ores which were often used with but slight preparation; but some of it is undoubtedly due to the potter's method, which left the door open to many of those "glorious uncertainties" which, while in one sense they are the bane of the potter's life, do at times crown his work with a glory not to be won by his most patient skill.

In addition to the three colours already mentioned, a few other colours were introduced locally, but without ever attaining to the universality of these three. Thus one of the distinctive colours of the variety of Persian pottery, known as Damascus ware (though it was produced in many places beside Damascus), is a violet colour obtained from oxide of manganese. More striking and more widely used is the brilliant opaque red known as Rhodian, because it was so freely used by the potters of Rhodes, and the adjacent coasts of Anatolia and Syria. This colour is altogether a singular one; it was obtained by piling on to the pottery in thick masses a clay material very rich in oxide of iron, which now goes by the name of Armenian bole; it has many drawbacks as an underglaze colour; it must be used in thick masses, which are liable to crack off the ware because of their thickness; if it is fired in a reducing atmosphere, that is if it is struck with smoke, or if it is overfired, it turns to dingy brown and yellow; any other glaze than an alkaline one dims its brilliance by partially decomposing it; add to this that it is always opaque, and therefore out of key with the rest of the underglaze palette, and one cannot but be struck with surprise and admiration at the skill of the potters who used it so largely, and on the whole so well. Another colour of very restricted and partial use was a yellow, made from a base analogous to the Naples yellow of the painter, and capable of yielding a powerful orange colour by the addition of oxide of iron. These colours, generally opaque, were never so much used in the near East as they were subsequently in the south of Europe, and particularly in Italy. The last colour we need mention is a fine black, used largely for outlines; this colour may have been obtained by grinding up a mineral of the basalt type, rich in iron; but in most cases it seems to have been made by grinding together the oxides of copper, iron, and manganese, as it is generally quite in key with the colour it outlines, while often there is a faint purplish flow from it which reveals the presence of manganese, or a greenish flow telling of copper. The complete underglaze palette, as here sketched, was a very simple affair, unfortunately far too simple for other peoples, who have successively altered it, until there is little of it left. The first great change seems to have followed very soon after the introduction of these methods into Europe. The Arabs and Moors in Spain, and afterwards the Saracan nvaders of Sicily, brought in their arts, of which pottery was an important one. In its new homes modifications began to creep in, probably from difficulty in obtaining some of he old materials, and from the discovery of new ones which would take their place; so that when the form of pottery, known as Italian majolica, which owed much of its inspiration, as regards methods and materials, to these ources, first became a distinct product in the 5th century, we find the siliceous slip coating, generally replaced by a coating of vitreous enamel, rendered opaque white by the large proportion of oxide of tin used in its composition. It is customary to ascribe the invention of this tin enamel coating to the famous Luca della Robbia; he doubtless improved it and brought it to a fine perfection, but the tin enamel was known and used by Saracen and Moor, particularly in Spain, where ores of tin abound, long before the birth of Luca della Robbia.

This change need in itself have produced little change in the palette, for the ground of tin enamel, though generally of a more creamy tint than siliceous slip, still serves well for the development of the old Persian colours. A change of far greater moment was the general addition to the alkaline glaze of a considerable proportion of oxide of lead. This entirely changed the chemical nature of the glaze, and as the proportion of oxide of lead was gradually increased, when it was found that lead glazes were more manageable than alkaline ones, generally melted at a lower temperature, and even that they would adhere to pottery of plastic clay, without the addition of silica to the clay or the intervention of a siliceous slip, then the palette had perforce to be adapted to the changed conditions, and we get the characteristic colours of the Italian majolica painter of the 15th and 16th centuries. Still these changes, though important and striking, can hardly be called violent or revolutionary: Cobalt blues were still as useful and as largely used as ever; the plain greens of oxide of copper still occur, but they are rawer and more self-assertive under the lead glaze; the glorious turquoise, under the action of the lead glaze, loses its character, and becomes a bluish green. Manganese oxide could no longer give under such a glaze its full rich violet colour, but only shades of purple brown, becoming browner as the proportion of oxide of lead increased; while Rhodian red disappeared entirely, for a lead glaze is very apt to decompose it, and so it ceases to be of any use. To replace the warm colours thus effaced, the yellow and orange colours were more largely used, indeed, the opposition of orange and blue is the dominant note in the colour schemes of the Italian majolica painters—the reason for which may be found in the fact that an alkaline glaze, with a good dose of oxide of lead, and worked over a tin enamel, developes the yellow and orange colours better than any other combination we are acquainted with.

When Italian pottery fell into extravagance and disrepute about the end of the 16th century, and a knowledge of fine pottery travelled north to France and the Low Countries, tin enamel and lead glaze travelled too, and in Rouen and Delft, reached another stage of development. Here the main influence at work was not so much Persian as Chinese grafted on to a stock of native pottery method. Chinese porcelain was finding its way to Europe in large quantities, in the vessels of the Portuguese and the Dutch, and it set the fashion. To rival the whiteness of Chinese porcelain, the composition of which was quite unknown, the tin enamel was made blue-white by the addition of a trace of cobalt oxide; and as, in order to make the ware hard (also from a desire to imitate porcelain), it was fired at a higher temperature than formerly, the only underglaze colours left to the French and Dutch potter which he could use with anything like certainty, were the cobalt blues; and to this imitative rivalry, and the altered conditions brought about by it, may be traced the extensive production of pottery decorated in blues only on an intensely white ground, in the 17th and the early part of the 18th century, and the almost total disappearance of the other underglaze colours.

This new problem of rivalling Chinese porcelain was, however, attacked in two other ways, directly by the production of European porcelains, which need not be further mentioned now, and indirectly by the introduction of white earthenwares. These two departures may be said to definitely mark the era of modern pottery, and between them they have practically destroyed the tin enamel coating, for such a coating is no longer necessary, when by careful selection of clays, and by the addition of ground flint, a body can be made white throughout its entire substance. This modern white earthenware body needs a glaze rich in lead to agree well with it, and so the underglaze palette has been practically reconstructed in England, France, and Germany during the last 130 years or so, to meet these new conditions. This third change has been an entire rebuilding, for the underglaze colours are now painted directly on the clay body, without intervention either of siliceous slip or tin enamel, and are glazed with a glaze containing as much as 40 per cent. of oxide of lead, and containing, also, new fusible ingredients, viz., borax or boracic acid. The starting point of the modern underglaze palette was of course cobalt blue, the one colour that had survived all the changes, and still remained in extensive use. Black seems to have been the next underglaze colour to be largely used; then with the help of modern chemistry greens were obtained, but no longer from oxide of copper which is quite unsuited to modern glazes, and their intense fire, but now from oxide of chromium, so that modern underglaze greens are much more olive in tint, and are duller of tone than the old ones, and are always opaque from the ingredients which must be added to the oxide of chromium to keep it from swimming under the glaze. It is no longer possible to obtain a reliable violet from manganese, we get instead a dark, earthy brown, while a more powerful and stable brown is got from chromate of iron. Yellow and orange are still got in the old way, but worked directly on the clay body they possess far less force and power than when worked on tin enamel. The old red has been very imperfectly replaced by a curious pink made by calcining a small quantity of oxide of chromium with a large proportion of oxide of tin, but this colour is much more interesting chemically than artistically, for it is a very opaque colour with little force in it, and when overfired turn to a nasty mauve. These with a number o nondescript mud colours, which are neithe pleasing nor important, are the principa underglaze bases used in England at th present time. The list has, however, bee much extended by the modern method o making all the different tints as so man different colours; in the old days when underglaze colour was painted, the painter coul mix his colours if he wished as he went on, fo all his intermediate tints; but now, when underglaze colour is mainly printed from engrave copper plates, such a method is no longe possible, but each exact tint must be prepare for the printer, who is, artistically, but part a machine.

It is, of course, quite evident, from what ha been said, that the underglaze colours mus be very different in composition and in pr perties from the old ones; and they are use with a quite different aim. Mechanical finis and not artistic excellence, is now the grea aim of all manufacture — to get an eve ground of colour without the least trace variation, and to repeat this thousands times in succession, is the point at which th modern potter is compelled to aim; and it astonishing to find how he is aided in such course by modern science. Take the case cobalt blue; the old potter would probably u as his pigment an earth which had been found by experiment to give a blue colour; such earthy ores seldom contain more than 20 to 30 per cent. of cobalt oxide, and mixed with it would be other oxides, generally those of nickel, copper, arsenic, and iron; all these would, of course, influence the final tint of colour given by such a pigment, and we get all the accidental variations which give the old colour so much charm. But the potter to-day obtains cobalt oxide from the chemist, who has refined the earthy mass, removed from it all the other substances, and sells a cobalt oxide which actually consists of 99 per cent. of that substance. In such condition it is far too strong to use as an underglaze pigment, and it is necessary, therefore, to mix it with certain colourless diluents, such as oxide of zinc, whiting, barytes, &c., and so we can obtain any desired shade of blue, always exactly the same shade of tint; but always too purple in tone to be altogether pleasing, and possessing neither the greenish tone of the old blue, nor its charm of inequality. The worst colour, however, made from cobalt is a falsely-named turquoise—matt blue is a much better name for it. This is got by calcining together a small quantity of oxide of cobalt with a large excess of alumina, and the result is an excruciating colour which harmonises with nothing, which loses all the beautiful depth which cobalt blues owe to their transparency, by being vulgarly and staringly opaque; and when such colour is laid in even flat bands on mugs and jugs and tiles, it would be impossible to do worse either with the potter's material or any other.

The influence of Chinese porcelain on the modern European underglaze palette has been already noticed, and in considering the question of *onglaze colours*, we shall have to go back to the same source for their *raison d'être*. We have already seen how the potter's palette needs to be modified, even revolutionised, to meet the requirements of different bodies and glazes, and the entire question of on-glaze colours, as distinguished from underglaze colours, is a most striking instance of this. Porcelain is, in many respects, the most artificial of the potter's products, resembling glass, indeed, rather than pottery, in its composition and in many of its properties. Thus with all ordinary pottery, the glaze is fired at a lower temperature than the body, and the adhesion between the two is not always perfect; but with true porcelain, the body is merely hardened so that it will bear handling readily, and the glaze, which consists largely of felspar, needs such an intense fire to melt it, that the second fire is much more severe than the first, and is, indeed, far harder than the biscuit firing given to earthenware bodies. Consequently, of all the underglaze colours widely known before the early years of this century, the cobalt blues alone are capable of standing such an intense heat without decomposition; and this is the reason for the extensive production of porcelain simply decorated with blues, not only by the Chinese, but by every people who have made porcelain at all. The other common underglaze colours, such as the greens from oxide of copper, the reds from oxide of iron, or the antimony yellows, are either flooded away into mere stain or are entirely dissolved and dissipated; therefore, if other colours are desired, they must be obtained by other means. Here, again, the analogy between glazed porcelain and glass would be at once apparent, and the glazed and fired porcelain is treated just like glass, and painted with the same colours, or with strictly analogous colours to those used for painting upon glass. All this had been worked out by the Oriental potters long before the introduction of their porcelain into Europe, and when efforts were made in Italy, France, and Germany to imitate this new pottery, the fact that some of the colours were painted on the glaze only was at once realised, for even before the rise of the porcelain works at Meissen, we find the faïence of Rouen and Delft decorated with patterns evidently imitated from, or influenced by, Chinese designs, and worked in colours of which the blue alone was underglaze, while the red and yellow used for lines and bands are both onglaze colours.

Admitting the necessity for onglaze colours, if any but the simplest effects are to be obtained on porcelain at all, brief consideration must be bestowed on the methods of preparing and using such colours. In order to fix the colour on to the already fixed glaze, some medium must be employed which will vitrify under the influence of fire. This medium, known as a flux, is prepared by making a true glass, melting at a low temperature; this soft glass or flux having been melted is ground to a fine powder, and then mixed with the true colouring matter. Sometimes a perfect mixture of the powdered flux and the colouring substance is sufficient to fit the colour for use; this is the case with reds, carmines, rose colours, browns, &c.: but for blues, greens, greys, &c., it is necessary to fuse the colour-base and the ground flux together, and the resultant strongly-coloured glass of low melting point must be once more ground to fine powder to fit it for the use of the onglaze painter. Speaking generally, colours prepared by fusion of all these ingredients are more transparent than those prepared by simply grinding. Prepared in one or other of these ways, the onglaze colour is then painted on to the fired glaze by the ordinary methods of glass-painting, in fact, onglaze painting is a branch of glass-painting; all the methods of retouching, and taking out with a point can be used. Instead of working directly, the final effect may be got by working a succession of tints over each other, with firings between each application. Unfortunately the artists at Dresden and at Sèvres, who set the fashion in onglaze decoration, delighted in the art of miniature painting, and niggling in general, and all European onglaze painting seems to be infected with the same bad influences; so that the freedom and breadth which cannot be entirely lost in underglaze work, because it must be done at once, with a full and free brush, without hesitation or remorse, is entirely lost, and one of the finest characteristics of pottery colour is lost with it.

After being painted, or printed, or dusted on to the oiled surface of the glaze, the piece is fired again in a closed muffle furnace, at a temperature so low as not to melt the glaze, but only to fuse the flux which thus binds the colours on to the glazed surface. In actual practice two degrees of heat are often used for onglaze colours—one, known in this country as "hard kiln fire," and used for certain grounds of red, blue, carmine, or rose colour; and the other, known as "easy or ordinary enamelling fire," for the common reds, greens, browns, yellows, &c., or for the firing of colours or gold on to those grounds which have already passed through the "hard kiln fire." At the easy or ordinary kiln heat the colour becomes merely attached to the glaze, without sinking into it appreciably; frequently it is dryer, and not so glossy of surface as the glaze, and it is often so imperfectly vitrified as to wear off under ordinary domestic usage, so that dinner plates and similar articles decorated with ordinary onglaze colours and gold, will show signs of wear after a few years of use. The onglaze colours fired through the hard kiln are not generally faulty in this respect, for the temperature being carried higher may approach the softening point of some glazes, and the colour and flux sink into the glaze and become incorporated with its outer surface. There is, of course, less objection to be urged against these hard kiln colours, therefore, either from the practical or the decorative point of view, but even this variety of onglaze colour never approaches in the depth and richness of its tone, nor in luscious transparency, to the best underglaze colours.

As onglaze colours only need to be exposed to a comparatively low temperature, the onglaze palette is a very extensive one; in fact with the additions that have been made during the last fifty years or so, the present onglaze palette contains all the requisites for the pictorial work beloved of the china painter, whether professional or amateur, in spite of its utter uselessness and fatuity as decoration. The mere enumeration of the onglaze colours would convert the rest of this paper into a string of names, so that we can do more than mention the sources from which the leading colours groups are obtained. Blues are as usual obtained from cobalt, but owing to the low temperature at which onglaze colours are fired, oxide of zinc must be added to the oxide of cobalt, to lighten the colour, which would otherwise be black. Oxide of zinc, a white powder, which yields no colour of itself, has a remarkable influence on cobalt blues, chromate of iron browns, and antimony yellows, for it reduces them greatly in tint, and enables them to give distinct shades of colour in mixtures that would otherwise be so dark as to tell only as black. This effect is not a mechanical one due to the mixture of a colour base with an inert white powder, but is due to the formation of fresh chemical compounds, of which the oxide of zinc is an essential ingredient. The same effect is produced by oxide of tin, but this is never used unless we wish to make the colour thoroughly opaque, which oxide of tin always does when it is mixed with pottery colours. Onglaze greens are obtained from both oxide of copper and oxide of chromium, possessing of course very different qualities, as one or the other colour base is used. We find oxide of iron in use for producing onglaze reds, as it will endure the lower temperature of firing without dissolving in the glaze or flux. Curiously enough the tint given by oxide of iron appears to depend mainly on the method of its preparation, and certain onglaze reds of the Chinese and Japanese have never been approached in Europe for luminous depth of colour and brilliance of tone. Yellows and browns are obtained from the same substances as the corresponding underglaze colours; but we have a group of carmines, rose-pinks, and flesh colours obtained from various preparations of gold, which are confined to onglaze use entirely, as they decompose when submitted to a glazing heat. We have in addition a group of colours of recent introduction, such as uranium yellow, iridium black, and platinum grey, but their interest is almost wholly scientific.

Many of these colours need special fluxes to suit their chemical behaviour, so that it is not always possible to mix them as a painter would mix his colours to get any required tint, and separate tints frequently require special and separate preparation. As a consequence, the making of onglaze colours has been made into a business; and owing to the imitative style of painting in vogue for china decoration, the number of tints has been multiplied until they must now be reckoned by the hundred.

One feels that the whole method of onglaze colour decoration is not so much a native growth of the potter's art, as an irksome condition thrust on the potter by the use of certain materials for his body and glaze; and the introduction of Oriental porcelain into Europe has not been an unmixed blessing, as many of the false potttery methods which are summed up and emphasised in onglaze work have followed in its train. Certainly no one who understands, and fully appreciates, pottery colour is likely to rank the finest triumphs of onglaze work with the simpler, but richer, effects of underglaze colour or coloured glazes.

It is somewhat of a relief to find that there is one small, but most important, section of onglaze colour work that is as much to be praised as the other is, generally speaking, to be condemned; that is, the department of *lustres*. Lustre-colouring, as magical and beautiful as the colours of rainbow and soap bubble; an art brought to perfection by the Persians as early as the 9th century of our era; introduced into Europe, along with so many other arts, by the great potters of the mixed Saracenic races; taking on new life and vitality in Italy for a little while, and then falling into disrepute, and well-nigh into forgetfulness; to be revived again in our own time only, in Italy, France, and Germany, by men who were artists rather than potters, and who appreciated so highly the worth of lustre as a decorative medium, that they set to work to re-discover it; all this is known to you, for Mr. De Morgan, the artist who first revived this lost art in England, has already spoken of the results of his labours to this Society, so that the subject is only referred to here in order that this imperfect sketch be not needlessly incomplete.

Lustre stands quite apart from every other form of pottery colour. It is produced by distinct methods, which would injure any other kind of colour; it is not in its finished form a pigment painted on to the pottery, and giving what we may call its own inherent colour; it is the colour produced by a film of substance, which may in itself be colourless, but which, from its extreme tenuity, acts on the light falling on it, so as to break it up into colour spray, if we may use such an expression. Lustre colours, therefore, belong to the same class as the colours of the soap bubble, the rainbow, or of precious opal, to which, indeed, they proclaim their kinship by their brilliant and changeful charm, soft pencilled, iris-dyed, varying with each new position or illumination. Lustre colours on pottery are generally associated with the yellow or orange stains produced by silver, or the gorgeous red tint of suboxide of copper, but this is merely accidental; those substances can be made to yield a thin film of reduced metal more readily than others, but the fact that they are strongly coloured in themselves has nothing to do with the lustre, which must be carefully regarded as an altogether separate effect. It is quite possible to get the yellow tint of silver, or the red of suboxide of copper, without any sign of the lustrous film upon it; and lustre may be got without distracting colour, as in the bismuth lustres, so well known from their use on the once popular Belleek ware. Bearing in mind that the effect of lustre is due solely to the way in which light is broken up and dispersed by thin films, which may be as devoid of inherent colour as soap and water before it is made into bubble, or as a rock crystal as distinguished from opal, we may proceed to consider how films so fine are produced on pottery. With all ordinary onglaze colours, a coloured glass is prepared which is painted and then fused by fire on to the surface of the glaze; but for lustre, a mixture is made of some metallic oxide or sulphide with an inert substance such as ground flint or china clay, and this mixture is painted thickly on to the fired glaze. The piece is then submitted to a comparatively low heat, which does not fuse the pigment; but with suitable substances, causes a portion of it to be volatilised, and this vaporous or volatilised portion is absorbed into the surface of the glaze, staining it either superficially or throughout its mass. For convenience sake we will consider more fully the production of copper lustre. Oxide of copper, or sulphide of copper in the state of fine powder, is mixed with china clay and painted on the fired glaze very thickly. The piece is then fired in a kiln so contrived that, when the kiln and its contents have been raised to a dull red heat, volumes of smoke, preferably from burning brushwood, can be turned into the kiln, so as to envelope the heated ware. Under this treatment the oxide of copper is partially reduced and vapourised, and this volatile portion is absorbed by the slightly softened glaze, which is consequently stained of a ruby-red colour; but if the action of the heated smoke, which is continually tending to deprive the copper oxide of its oxygen, be carried further, then the surface-film of the copper oxide absorbed by the glaze, is reduced absolutely to metallic copper, and if the action be stopped at the right moment, we get a glaze stained of a beautiful ruby-red with the volatilised suboxide of copper, while over its surface is a layer of metallic copper, so thin as hardly to show its characteristic copper colour, but glowing instead with the changeful iridescence of lustre. When the pottery is first taken from the kiln, nothing of all this is apparent; the article is all black with its coating of unused copper oxide and clay, which needs to be vigorously scrubbed away before one can see whether the operation has succeded. Too often, alas! the result is a failure. In the majority of passable pieces some will show the red stain, glorious in itself as colour, but with little or no effect of lustre, the copper film not having had time to form, others will have gone to the opposite extreme, and the red colour can only be seen fitfully peeping through a mask of copper, which blinds one with its dazzling glare; while one or two pieces will show just the perfection of prismatic colour, shimmering and displaying itself upon a background of gorgeous red. Happy the potter whose kiln produces many such pieces! Fortunately, perhaps, from the very uncertain operation of the methods described, lustre cannot be produced in endless quantity—fine pieces will always be comparatively rare—so that this beautiful process, at all events, may remain for some time longer unaffected by the vulgar fate that seems to have overtaken most of the potter's colours and methods in this steam-engine driven age.

To consider the last and, essentially, the most modern of all the great colour groups tabulated at the commencement of this paper, we come to the effects obtained by actually incorporating the colouring matter with the glaze material before it is applied to the pottery. In all the cases hitherto considered, it has been assumed that the glaze itself was transparent and colourless, or nearly so, but it is at once evident that if the glaze itself can be strongly or delicately coloured, we get a great extension of the potter's colour resources, not merely in the extent and variety of colour procurable, but also in the quality of that colour. Clay colours are necessarily earthy and opaque; and underglaze and onglaze colours are frequently so, but when a colour is actually dissolved in the glaze, it assumes the transparent limpidity and richness of the colours of stained glass, and thus the colour is lifted on to a higher plane at once. In connection with this dissolving of the colour in the glaze, one little point of great importance in underglaze colour work may be referred to here. It has been already pointed out, in comparing the old underglaze greens, made from oxide of copper, with the modern underglaze greens, made from oxide of chromium, that the former excel the latter by their transparent brilliance. The scientific reason of this difference in quality is, that the oxide of copper used formerly, and which of itself is not green, but black, unites, under the influence of the firing with the silica of the glaze, forming silicate of copper, which is green, and which actually dissolves in the glaze above it; so that the old underglaze green may be looked upon as the local staining of a glaze, with copper oxide painted on the body in patches. Chromium oxide, the modern pigment, is in itself green, but it does not combine with the glaze, nor is it dissolved in it; it is only superficially penetrated by the glaze, and held in suspension, so that it cannot become really transparent; in fact, compared with the older green, it is distinctly opaque. Oxide of cobalt behaves exactly like oxide of copper in this respect; the actual pigment used by the potter for underglaze blue is a dense black powder, but when the glaze is put upon it and they are fired together, the oxide of cobalt is dissolved by the glaze with the formation of silicate of cobalt (the smalt of the painter), which of course colours the glaze locally, giving the transparent softness of blue underglaze; and that modern underglaze colour, Matt blue, already spoken of as so staringly opaque, is so, because it is not silicate of cobalt, but aluminate of cobalt, which the glaze cannot dissolve into transparency; it cannot, indeed, thoroughly penetrate it when it is laid on in thick masses.

This little interpolation is useful, because it serves to establish at once the full and final distinction between the two great classes of coloured glazes, the transparent and the opaque. By transparent coloured glazes we mean those in which the colouring matter is perfectly dissolved by the molten glaze, as sugar would be by water; and the opaque, coloured glazes, which are opaque because the colouring matter is not dissolved, but is merely held in suspension by the melted glaze, as clay would be by water. Both the transparent and opaque varieties of coloured glaze are spoken of by potters as enamels, but this term ought, in strict accuracy, to be applied only to the opaque varieties, of which kind the enamel coatings used by Luca della Robbia for coating his terra cottas, may be taken as the highest type; and speaking generally, it would be well to speak of pottery as glazed when it is covered with a transparent glaze only, and enamelled when it is covered with an opaque glaze.

Which of these two classes of coloured glaze is the older it would be fruitless to enquire, seeing that the Egyptians made their turquoise glaze, "which remained unrivalled for twenty centuries," both in a transparent and in an opaque variety, but ancient usage seems to have inclined for the most part to the use of enamels or opaque glazes, as we find them in the remains of the earliest Assyrian brickwork, and in the early examples of Saracenic tile work in Egypt, the north of Africa, and Spain. It is probable, however, that the making of transparent and opaque glazes went on in many places side by side, and it is of interest to note that the native and indigenous pottery of all the northern and western countries of Europe was, from a very early period, decorated with a common transparent lead glaze, usually stained a strong green colour by oxide of copper, but not infrequently stained yellow by oxide of iron. All over Europe and Asia pottery such as this has been made for centuries in the most primitive fashion, until it has been pushed into the background and lost sight of when finer methods have been introduced. An examination of the specimens of early European pottery in any museum will show how widespread in their use such glazes were before Italian majolica or Chinese porcelain had been seen on this side the Alps. With such a widespread use of one or two coloured glazes it is astonishing to find how little this method was used in Europe until quite modern times. They were used in Spain by the Morescos, and for those tiles designed with perfectly geometric patterns that Mr. Garrod revived in this country a few years ago; they were used by Palissy in the decoration of his rustic wares, and then little more was done with them down to about 1860, when the Wedgwoods in this country, and certain potters in France and Germany, introduced a great variety of coloured glazes, and produced what is now known as majolica ware, but which should rather be called "Palissy ware," if its name is to be derived from earlier analogous work. In extensive use, therefore, decoration by means of coloured glazes must be looked upon as a modern departure, and an important one, when it is judiciously used.

The method of preparing and applying these coloured glazes is of the simplest. The colouring oxides, which are limited to the few already so familiar, viz., oxide of cobalt for the blues, oxide of copper for the blue-greens, oxide of iron for yellow and orange, oxide of manganese for violets and browns, form the stock bases for coloured glazes, as they do for underglaze and onglaze colours. The particular colouring oxide required is reduced to the finest state of subdivision, and is then mixed with the ground, glaze material, while they are both in suspension in water as insoluble powders; the piece of pottery is dipped in this glaze mixture just as it would be in an ordinary glaze, or, if more than one coloured glaze is to be applied to the same piece of pottery, the coloured glazes are separately painted on to the required places, and the piece is then fired, so as to melt the glaze. The temperature of firing is generally lower than would be used for an ordinary colourless glaze, so as not to impair the beauty of the fired colour. As the glaze melts with the heat, it dissolves the colouring matter, generally with the conversion of the oxide into silicate; and when cool the ware is covered with a coating of beautifully coloured glass. Of course if the colouring matter is one which does not dissolve in the glaze, but only remains disseminated through it and held in suspension, then we get an opaque glaze or enamel. Some of the colouring substances in ordinary use, such as Naples yellow, chromate of iron browns, and the tin-chromium compounds used to produce the glaze known as *sang-de-bœuf*, will not perfectly dissolve in the glaze, and so they always produce glazes of varying degrees of opacity; while a transparent colour can always be converted into an opaque one by replacing a portion of the oxide of lead in the glaze, by oxide of tin, or by the addition to it of one or two other compounds, but in this case the resultant tone of colour is greatly modified. In the case of one or two special glazes it is necessary to melt together the ingredients of the glaze and the colouring substance, and so prepare a coloured glass which is then ground up and applied to the surface of the pottery. This is notably the case with colours dissolved in alkaline glazes, which are always more difficult to manage than lead glazes ; but that is a purely technical point which need not detain us now.

Having briefly considered how coloured glazes are prepared, we must mention the various considerations which affect their employment, or modify the actual tint produced. The range of tints that may be got by careful adjustment and mixture is extensive and varied, for not only can we vary the amount of colouring oxide, say from 1 part in 1,000 of glaze, which is quite sufficient to give a decided tint with the stronger bases like oxide of cobalt, to 1 part in 10 of glaze, which proportion many glazes will dissolve, but we can make regular mixtures of two or three colouring oxides in one glaze, and as the proportions of each oxide may be similarly varied, and will always tell in the colour produced, the variations of tint possible in coloured glazes are practically endless.

Apart from these considerations which are quite simple, being matters of chemistry and arithmetic, there are one or two others which powerfully influence the result, but which are not quite so simple, nor so easily controlled, *i.e.* (1) the composition of the glaze, and (2) the degree of fire needed to melt that glaze ; then of course the effects of varying fire, and the penetration of gases into the kiln during the firing, which cannot be perfectly controlled or estimated, also come into play in a minor degree.

It has been already noted how the underglaze palette changed when glazes passed generally from a base of alkaline silicate (silicate of potash or soda) to a base of silicate of lead; and of course this influence is more powerfully operative when the colour is actually in the glaze, and is fully exposed to its chemical action throughout. For the most part alkaline glazes are no longer used except for such colours as cannot be obtained by any other means ; such colours, for instance, as the turquoise glaze from oxide of copper, or the violet glaze from oxide of manganese. Most modern coloured glazes are made with a large proportion of oxide of lead, because such glazes are more manageable, melt at a lower temperature, and do not alter so sharply in tint with varying fires ; and with regard to the proportion of oxide of lead in the glaze, the larger the proportion, the darker and richer will the colour be, and the more bloomy and velvety its surface. Briefly, lead glazes give richer colour, alkaline glazes more brilliant colour. Most important is the action of fire ; for starting with the same mixture of glaze and colour, it is possible to produce the most curious variations, not merely in tint, but in actual colour shade by exposing it to different degrees of heat. All colouring bases show this to some extent, and some few coloured glazes have their colour entirely destroyed by exposure to a temperature only slightly higher than that needed to develop their full tint, because at a higher temperature the glaze not only dissolves the colouring matter but decomposes it, forming new compounds which may be colourless, or of quite different colour to the one desired ; the deep crimson glaze, known as *sang-de-bœuf*, is very liable to this decomposition from over-firing. Glazes coloured with oxide of cobalt, oxide of iron, and oxide of manganese undergo a very curious bleaching action if they are fired at too high a temperature, or even if they are exposed to their proper temperature for too long a time. While oxide of copper, being somewhat volatile at a fairly low heat, is the most unreliable of all colour bases when dissolved in a glaze, and whether dissolved in an alkaline or a lead glaze, is so altered in tint by alterations of temperature in firing, that it might be possible to use it as a trial to fire by, judging the temperature by the tint obtained with a glaze containing a given proportion of oxide of copper.

Beautiful and precious as these coloured glazes are, they are so difficult to keep constant in tint, from the readiness with which they show even slight differences in composition or in firing, that the pottery manufacturer, who feels himself tied down to produce mechanical effects, finds them the most troublesome of all colours to manage. Of course the easily melted glazes will flow thick and thin ; they will vary in tint as they are fired ; and when more than one colour is used on the same piece, they will run together slightly, and produce broken colour, all of which gives them artistic charm, but damages them sorely in the eye of the modern dealer in crockery; and the potter who gave way to his artistic impulses in the direction of coloured glazes, would find considerable difficulty in disposing of his wares.

One can see how naturally the various methods and kinds of colour that have been lescribed can be used in conjunction with each other. Clay colours may be used under a coloured glaze, often with great enrichment of the tint, and the effect may be brought about in two ways, simply as the glazing of one colour by the superposition of another, but in the case of the darker clay colours the glaze often absorbs some of the colouring natter from the fired clay, and is thus additionally modified. A distinctly modern invention is the use of two or three printed, or painted, underglaze colours, with a coating of ome coloured glaze over the whole; a method which, while it harmonizes the various underglaze colours, is apt to reduce them greatly n value, though it often develops very beautiul and somewhat accidental effects of colour hat are not to be got in any other way. Laterly, the process of combining underglaze olour and coloured glazes has been carried a tep further, and coloured glazes are actually ainted on the ware-like pigments, with the hadows given by deftly applied patches of nderglaze colour beneath them.

The combination of underglaze and onglaze olours in the decoration of the same piece ; a much older device, the strong reason r which has been already touched upon. he Italian majolica painters doubtless uched up their outlines after the painting ad been fired, but then the piece was red at almost the same temperature as at rst. The combination of blue underglaze ith red, black, and green pigments and gold pplied on the glaze, is almost a necessity for e porcelain painter; and, since the general troduction of porcelain and its methods, has een increasingly applied to the decoration of rthenwares also. The process, although in ch widespread use, and entirely unavoidable, certain effects are to be obtained, is never ite satisfactory; the on glaze colours are variably a little out of key with the underaze colours, being harsher, less glassy, and ore opaque; while they have the further dislvantage in use, that in many cases they will t stand active wear; so that one finds plenty modern pieces in which the gold and the glaze colour have been worn off in patches, ile the underglaze colour, deprived of meang as a pattern, is as fresh as ever. Of course, onglaze colour will stay where it is put, without flowing or shifting, and fine and firm outlines can be obtained by its use; but the Persians, both in ancient and modern times, obtained underglaze outlines as fine and as still as need be, and their general result is much more satisfactory.

Finally, to compare the results obtained by the modern potter from all the varied colour methods open to him with the results obtained in bygone times, with much simpler and more limited means, one feels that the results are far from satisfactory, and mainly because the modern potter seems so often to desire the impossible, and to work in opposition to the natural tendencies of his materials. He is hampered, too, by the modern mechanical and scientific tendencies, which seem to direct him into the dull channel of uniformity. Modern chemistry is too much bound up in big text books to be readily applicable to his business, while the chemist on his side, has refined and purified the potter's colour materials to the utmost possible limit. Oxide of cobalt is now oxide of cobalt and nothing else; oxide of copper is oxide of copper with no traces of iron, arsenic, or antimony in it, and so on; of course this is all to the good from the point of of view of accuracy and precision of result; it enables one to fix absolutely the best proportions of material for any given purpose, and to obtain again and again, with tolerable certainty, the same effect of colour and of richness; but it prevents the modern colours from possessing one of the great charms of old colour, that inequality of tint, which by introduction of variety makes the colour interesting and precious. More than this even; it has proved impossible, hitherto, by most cunning device of combination or mixture to obtain from purified oxide of cobalt and oxide of copper some of the tones that the Orientals got by working with impure or earthy mixtures, in which the cobalt or the copper were mingled with other substances in indefinite proportions, and in this respect the advances of modern chemistry have caused a distinct loss to the potter.

But the worst of our modern troubles is the aiming after a false mechanical perfection to suit the tastes of mechanical and inartistic people. Our clay bodies are too fine in grain and too smooth of surface; the colours themselves are applied too mechanically, and too often with a single eye to flatness of texture and absolute uniformity of tint; the choice of colours and methods has passed from the hand of the artist into that of the manufacturer, who is compelled by the exigencies of the market to produce thousands of articles as much alike as possible. Processes and colours must be used which will produce the largest proportion of saleable articles, and a fine colour or a good direct process may be entirely abandoned because it shows too readily and sensitively the effects of variation in fire and glaze which the potter, try as as he may, can never entirely avoid; and ought not to wish to avoid entirely, seeing that they are natural to his methods. The Persian or Italian pottery painter was just as much at the mercy of these accidental variations as we moderns are, but as the aim and purpose of his work was so different, he could afford to rejoice in his uncertainties, and turn them to artistic account. When he found that certain results were likely to follow which he could not with absolute certainty either control or predict, he played with his materials, not against them; leaving them a margin, so to speak, to disport themselves in, and often with the happiest results. It is necessary to clearly realise the difference of aim and intention, or we shall duly exalt one set of potters at the expense of the others, forgetting the influence of the times, which makes it as natural for one set of people to do an artistic thing, as it is for the other set of people to do a mechanical thing.

The paper was illustrated by a large number of specimens of tiles and other modern pottery, and by coloured lantern slides, also by a collection of historical specimens, kindly lent by the Science and Art Department.

DISCUSSION.

The CHAIRMAN said the lecturer had given them a great deal to think over, perhaps more than they could digest in so short a time, and had raised many interesting points. When he spoke of the difference in spirit between the modern method and the ancient, he really touched the root of the matter. The modern reliance on scientific precision of method had been attained at the cost of artistic charm, and unfortunately they had created a taste in the public for that kind of thing, which made it very difficult for artistic manufacturers like Mr. Burton to indulge their taste in the most truly artistic manner. They were more or less tied up by the market demand; some said it was all the fault of the trade, whilst others laid the blame on other shoulders, but he feared they were all more or less responsible in varying degree.

Mr. LEWIS DAY said Mr. Burton had given them about as much as they could carry away, and it would be quite out of place to attempt to add anything. At the same time, he must confess that he was a little disappointed that he had given them nothing to quarrel with. He (Mr. Day) had had many talks with him, and knew him to be not only a potter, but also a chemist, and a lover of art; and he rather expected that he would have taken more the scientific point of view. He had expected him to anathematise accident in pottery, but he had simply glorified fluke. He had also heard him say very disrespectful things about lustre, but to-night he had simply blessed it altogether. Probably thinking he ought to say something about lustre, he had looked into it, and found how beautiful it was. It was very interesting to see how the whole art of the potter was the result of circumstances, and how he had not so much chosen his palette, as his palette had made him do the things he did. When scientific men spoke about artists, they often rubbed them the wrong way, but Mr. Burton had stroked them very gently indeed, and was eminently deserving of their thanks.

Mr. HUGH STANNUS said he had been very much delighted at the thorough grip of the subject which Mr. Burton had shown. Some time ago, when looking out for some artistic tiles for a client, he searched in vain in various London warehouses, but, finally coming to Mr. Burton's shop in Whitcombe-street he found some extremely artistic work. All artist and architects were indebted to men such as he, who combined the thorough knowledge of the chemis with a fine artistic sense of colour. The paper h had now given was, beyond doubt, the ablest t which he had ever listened in that section. Not onl the committee of the section, but the Society at larg and the outside public who would read it in th pages of the *Journal*, were much indebted to him.

Mr. W. P. RIX said he should like to add his quot of admiration, as he could probably appreciate mor than most the difficulties which Mr. Burton ha referred to, and could sympathise with him. Fe but those actually engaged in such work, knew ho the art potter was fettered, and the difficulties unde which he was placed in dealing with the averag commercial demand. At the same time, it was great advantage to have Mr. Burton ranging himse with those who would simplify the palette of th potter, and make his working methods more eas But, after all, those who dealt with this matter i the most skilful way would undoubtedly follow th direction in which they were led by the conditio of the medium in which they worked. By s doing, and by the simplification of the palette, the would produce more artistic work than they wer allowed to put before the public by the average shop ceeper. If they would accept the exigencies of the ase with more courage, they would perhaps be able o secure the sympathies of artists more than they ad hitherto done.

The vote of thanks having been proposed by the HAIRMAN, was carried unanimously.

Mr. BURTON, in reply, thanked the audience for aving listened so patiently to a long lecture, and aid he was sorry he had disappointed Mr. Day, who seemed to think he was a recent convert to stre; but, in fact, it was some years since he ave a lecture at the Technical Museum at Hanley n "Soap Bubble Colours as Applied to Decoraion." If he had had more time he could have given nore information; and he hoped at some future time o have an opportunity of doing so.

TWELFTH ORDINARY MEETING.

Wednesday, February 26, 1896; SIR ALEX. . MACKENZIE, Mus.Doc., in the chair.

The following candidates were proposed for ection as members of the Society:—

ooper, John Manning, 8–10, Great Pulteney-street, W.
obson, John R., Brompton, Northallerton, Yorks.
upré, August, Ph.D., F.R.S., Cliftonville, Sutton, Surrey.
ing, Frederick William, Heybridge, Maldon, Essex, and Council Offices, Ilford, Essex.
cHardy, David, J.P., Cranford, Ruthrieston, Aberdeen.
axwell, Hon. Joseph Renner, M.A., B.C.L., 11, Wellington-street, Bathurst, Gambia, West Africa.
ontgomery-Moore, Alexander Willoughby, Holland-lodge, Eltham-road, Lee, S.E.
urray, Thomas Blackwood, B.Sc., Heavyside, Biggar, N.B.
homson, Charles, Glenmount, Tierney-road, Streatham-hill, S.W., and South Wharf, Rotherhithe, S.E.

The following candidates were balloted for, d duly elected members of the Society:—

ker, Edward, 10, Philbeach-gardens, South Kensington, S.W.
arris, Harry, care of The Straits Trading Company, Singapore.
olmes, Henry, 20, St. Lawrence-road, North Kensington, W.
nes, Robert H., Ardenham, The Grange, Gunnersbury, W.
eynolds, Edward P., Clovelly Tower, Ranmoor, Sheffield.
arden-Stevens, Frederick Joseph, Martin's-chambers, Cannon-street, E.C.

The paper read was—

THE STANDARD FOR MUSICAL PITCH.

BY A. J. HIPKINS.

This question is again agitating the musical profession and musical amateurs of the country, and in particular the desirability of our accepting the French standard or diapason normal of A′ 870 single vibrations in a second of time at 15° Centigrade, equal to 59° Fahr. is considered. Reckoning by double or complete vibrations, this number becomes A′ 435. I shall continue with double vibrations, during this paper, as is our custom in this country, and shall speak of the diapason normal as the French pitch, and of the sharper English band pitch as the Philharmonic, although the Philharmonic Society is discarding it, to adopt the low French pitch.

I am myself in favour of the French pitch from the point of view of expediency, inasmuch as it has been generally accepted, and to a great extent adopted, on the continent of Europe, and also in the United States of America, while no other standard that could be proposed, in this country or elsewhere, is likely now to be considered. The pitch of the London Philharmonic Society has been nearly constant from 1846, and the tuning-forks for it have been approximately C 538 and A 452·4 double vibrations in a second, about two-thirds of an equal semitone, or a chromatic semitone higher than the French fork. French A $435 + \frac{2}{3}$ equal semitone = 452·24; chromatic semitone = 453·125. The advocates of this high pitch maintain that it is what they have been accustomed to, and that orchestral instruments, string and wind, sound brighter with it, and also the pianoforte. And they can point to some of the greatest singers in the world—to Grisi and Mario, and others hardly less famous—who for years went through long and exhausting operas at this high pitch, apparently without undue strain, and, so far as is now known, without complaint. There would occasionally be transposition but it was not invariably downwards. And further, that at this present time some of the leading opera and concert singers, prefer the high pitch, to which I can bear witness. To give a recent example from the Queen's-hall, in a concert where pianos were provided at the Philharmonic and the French pitches, the singers, with two exceptions only, and including Mr. Lloyd and Mr. Santley, sang by choice to the accompaniment of the high pitch; the exceptions were Miss Macintyre and Mr. Bispham, who preferred the French pitch. This may be accounted for, as both were at the time engaged at the Opera, where the low pitch obtains. Covent Garden Opera was lowered in 1880 to French pitch, after some attempts at an intermediate one, to please Madame Adelina Patti whose voice had changed in position, while she still sang the same parts, and it has remained at that standard, with due allowance for temperature of which I shall presently speak. This fact of the low opera pitch existing with a high concert pitch proves that in this country, a high and a low pitch may exist together and be open to choice. The Philharmonic Society has willed to have the low pitch and can have it, and also the symphony concerts over which Mr. Henschel presides, the Wagner concerts of Mr. Schultz-Curtius, the Strolling Players and the Bach choir, but with the last-named there has been a greater obstacle to overcome—the high pitch of the large concert organ in the Queen's-hall. This instrument having now been satisfactorily lowered, oratorios at French pitch in the Queen's-hall have become possible, and so far as the Queen's-hall is concerned the French pitch is as settled as it is at Covent Garden, or in Paris. Elsewhere in this country, at the Royal Albert Hall, at the Crystal Palace—the large provincial halls of Manchester, Leeds, Liverpool, Bristol, Norwich, and Glasgow — the organs must be lowered before oratorios at French pitch can be performed, and that means an expensive operation in shifting the flue pipes a semitone down, and then cutting them to the measure required for French pitch. The reeds are also a material consideration. I am not aware that the advocates for a high pitch have ever pleaded its suitableness for a chorus, the reason for this being that the great sacred compositions which preceded Mendelssohn's "St. Paul" and "Elijah," were composed by Handel, Bach, Haydn, and Mozart for a pitch even lower than French—a diatonic semitone below philharmonic—so that all these works, when rendered at the latter pitch, are virtually transposed upwards by that interval, which renders the high notes of ordinary untrained sopranos and tenors difficult of attainment. The average vibration number of this very low pitch, called Handel's, because a tuning-fork exists, the possession of which has been traditionally attributed to him is A 422·5. The fork was for many years i my care, and is now in the collection of th Hon. Levi Fuller, of Vermont, Massachusetts The attribution is probably correct, but if no once Handel's, it still represents the pitch o his time. It is the mean pitch of the late D A. J. Ellis's "History of Musical Pitch," remarkable lecture in many respects, whic was read before this Society in 1880, an should be republished. Dr. Ellis called i mean pitch because it was an intermediat grade between the very low and very hig Chamber and Church pitches of Arnol Schlick, viz., A 377 and A 504, a differenc of the interval of a fourth. Schlick's boo was published in 1511 at Heidelberg. W might also call it the violin pitch, as th introduction of that instrument to genera use banished the extremely high pitch the lutes and viols it superseded. The mea pitch, as will be shown, predominated unt about the year 1820 I do not mean to say was a real standard, such as we understan by a standard of weight or measure, but lasted, as a generally accepted compromis during the whole of the 18th century, agre able to singers and favourable to the ri and development of the orchestra. I belie Schlick's high and low pitches, with a fourt between, was to permit the common transp sition in choir music by that interval—betwee the staff, without a sign of transpositio regarded by us as the key of C, and that, wi a sign of transposition, the B rotundum or flat, denoting the key of F. The two ke boards of a double harpsichord were not su gested by the contemporary organ, but we originally contrived to enable the player to effe this transposition without changing the keys the fingering. The historical progress of pitc as was shown by Dr. Ellis, was in the directi of bringing the extremes nearer to one anoth until, in course of time as mentioned Prætorius in 1618, there was only a min third and even less difference between the The organ of the St. Jacobi Church at Ha burg, built between 1688 and 1693, was co trived with two pitches: A 489, a whole to above French for the instrument general and one stop, an 8-feet Gedact, A 411·4 (j A 407·7), a semitone lower than French pitc With no fixed standard such control o pitch as existed depended upon the singe voice, and to some extent also upon the i strument maker's convenience. The foot r of the organ-builder, with which he start is scale depended to a great extent upon cality. He might use the French Pied ı Roi, the Rhenish foot, the English, or ıe Bavarian. According to Dr. Ellis, the ıort Saxon foot of 283 millimetres would be mean tone sharper than the Rhenish 314, or the Austrian of 316. A very ıportant determination was also the note for hich the foot pipe was placed. Intended iginally for C, it might be shifted to B ıtural or B flat, and even lower, thus raising e pitch of the organ by gradations of a mitone, a whole tone, and so forth. Dia- eter and wind pressure are also very import- ıt qualifying influences; all these conditions, ıusing considerable variation, were only to controlled by the natural capabilities of the nger—in those days chiefly the male singer. am thus led to the voice which is to be garded as no less persistent in men and omen than other attributes, such as stature, ımplexion, and the senses, all of which, in e five or six hundred years we have to do ith, offer no varieties that are not existing at e present time. There may be deep basses Russia, and high tenors in the South of ance and Italy, but they can be accounted r and mapped out without disturbing the erage.

The complete compass of the human voice men and women may be taken as four oc- ves, from C sharp to C sharp at French pitch, C to C at philharmonic. Any lower or gher notes are, or are nearly, abnormal. I lieve I do not err in stating that the section this compass, which is known as the chest gister, ascends only with safety to the C arp, next to middle or clef C, at philhar- onic, or D at French pitch, while tenor and omen's voices may ascend with this register E or F. Below these notes the medium gister comes in and extends higher to B flat B natural in the treble clef, the C in the eble clef being the highest note with this gister attainable. Parallel, again, with the per notes of the medium is the so-called ad voice, which, with women, may rise to C ove the treble clef at philharmonic, or C sharp French pitch, and be a sustained note. In y modern consideration of pitch, it is not quired to consider any greater divergence an a semitone. When, in old music we serve a very low compass indicated, we ay be sure the pitch was very high. For ample, Praetorius, in 1618, takes his bass ice down to C below the staff, and says tenor should take the E and an alto the G in the treble clef. I interpret this, assisted by other evidence, as meaning that a basso profondo should be able to sing down to E flat, a tenor up to G, and alto to B flat. His chamber pitch, as he called it, was therefore a minor third higher than French, and this was the church pitch of Tallis and Byrd in England in the previous century, as is shown in their compositions for the church. At the dinner of the Royal Society of Musicians last year "Non Nobis Domine" was sung in B flat. The old copies are in G, which also shows a difference of a minor third in the pitch. Praetorius however had a suitable pitch for church music and gave the measurements for it, according to which Dr. Ellis had an organ-pipe made which sounded A 424, approximately Handel's. It was to this moderate pitch violins could be tuned with a fairly thick stringing and care for the preservation of the first string. In this century we have increased the violin tension two-fold—by higher pitch and by a longer neck to the instrument.

I pass from the voice and the older historical phase to consider the rise of pitch during this century and how it came to pass. There are trustworthy particulars embodied in the report of the French Commission and quoted by Dr. Ellis, of the rise having begun during the Congress of Vienna when the Emperor Alexander of Russia, who was colonel of an Austrian regiment, presented it with a new set of instruments sharper than the pitch hitherto usual. In 1820 another Austrian regiment received new instruments which were even sharper. Increased brilliance of effect soon spread this innovation throughout Europe. The Philharmonic Society of London was founded in 1813, just before this change took place, and the fork that was used for tuning the Broadwood pianos was C 506·8, which in the meantone temperament then current was equivalent to A 423·7, practically mean pitch. As early as 1821 we observe an upward movement beginning in this country. Greatorex, then the organist of Westminster Abbey, had the organ raised in pitch for the coronation of George IV. —perhaps to go with a band. From that time for nearly thirty years it was not a cry for lowering as now, but for raising the pitch. Sir George Smart was the ruling authority; his high character and experience made his the predominant influence. He could not, however, in later years recall when the occasional halts took place that were made to record the higher stage of pitch arrived at.

But two witnesses remain in the tuning-forks A 431·5 (meantone C 516·3) and A 433·2 (meantone C 518·2), the former lent to me by Mr. George Case, was given by Sir George Smart to the late Sir William Sterndale Bennett, as being the original Philharmonic fork; it was certainly not the original, but possibly the first record of a raised pitch—the latter belongs now to Mr. Algernon Black, inherited from his father, Mr. John Black, to whom it was left, in its well-worn striped silk sheath, by Sir George Smart as his own Philharmonic fork. The difference in the vibration number of these two forks marks an interval of time, not of long duration, but sufficient to prove a reconsideration of the pitch of the Philharmonic orchestra. There can be no doubt about both being genuine. But we arrive with A 433 very nearly at the level of the French pitch A 435, which was anticipated at the Paris Conservatoire and Italian Opera, according to a fork tuned by the violin maker Gand, and accepted by Scheibler as correct, in 1834. We may therefore assume the validity of the second Sir George Smart fork at about that date. Scheibler's "Tonmesser" (pp. 52-3) records several contemporary pitches, and, with Dr. Ellis's corrections from 69° to 59° Fahr., they include Vienna minimum, A 433·9; Paris Opera, A 434. Paris Conservatoire and Italian Opera already mentioned, A 435·2 — Vienna Opera A 436·5 and A 439·4, this difference is unexplained unless it was one of temperature. The last led to Scheibler's A 440, which was proposed by him in that year for a standard pitch to a Congress of Physicists at Stuttgart—not professional musicians, as has been stated and frequently repeated. Nothing came of this proposal but the record. But this pitch, applied to the orchestra of about 68° (20° Centigrade), practically represents and exceeds by a small fraction only the standard pitch of the French Government, with correction for the rise of temperature from the official 59° (15° Centigrade). The French Commission of 1858-9 included the eminent composers Halévy, Auber, Meyerbeer, Rossini, Ambroise Thomas, and Berlioz, who had all written for the voice, with Despretz and Lissajous to represent science. It is known that Lissajous was responsible for the vibration measurements. It is further understood that Berlioz was for retaining the pitch then arrived at in Paris, A 448 (just C 537·6, equal C 532·8).

Paris being at that time lower than London, we have to go back to 1844 for A 448, when the clarinet of Lazarus at that time Costa's clarinettist was, as subsequently measured by Dr. Ellis and myself, at that vibration number Lazarus himself gave the note. This pitch dates back to my first acquaintance with public concerts, but from 1840 I have been an observer, and have taken notes of musical pitch In 1840, the tuning-forks sold in the trade were all at Sir George Smart's pitch, abou C 518, and were stamped Philharmonic. Bu these forks were accounted flat for instrumenta purposes, and the tuners raised their pitch by filing them as they thought fit. A year or tw later Messrs. Broadwood issued to their tuners forks that were somewhat higher, in orde to obtain uniformity, and I distinctly remember that Hullah's fork, issued about 1842 stamped C 512, and intended for a standard, was very nearly the pitch of these Broadwood forks. I had understood that thi so-called philosophical pitch of C 512 was ver low, but recent measurements of Hullah' unaltered forks show them to have been C 525; a mistake had, therefore, been made or, rather, the means employed were inefficient for determining the vibration number The complaint was always being renewed tha the concert pianos were flat. The new fork were filed, the wind instrument players, consciously or unconsciously, in getting new instruments, had them made sharper, and th violinists screwed up, so that by 1846, when Mr. (afterwards Sir Michael) Costa came t be the conductor of both the Royal Italia Opera and the Philharmonic Society's concerts, with the same wind band in both, th band pitch had risen to what we now understand by Philharmonic A 452·4 or ·5. Th pianos being still accounted flat when used i these concerts, it occurred to my father-in-law the late Mr. John Black, of Broadwoods—I believe in the season of 1849—to obtain Costa' permission to tune a fork between the part of a concert, that should be virtually a standard. I have an exact copy of that fork mad at the time, which has been in my care eve since. It is C 538·2 (Equal A 452·5). It wa copied and sold by Greaves and other tuning fork makers as Costa's Philharmonic, an became attributed to that eminent musica and conductor as one of his own devising, bu I think we may be satisfied that it was no and that it came about through a natura tendency to keep up in pitch, a tendency th extensive publication of the fork helped in great measure to restrain; so that the Philharmonic fork has only been once revise since Costa, and then at the instance of th ate Sir Charles Hallé, who, in 1874, finding he piano flat to the trumpets in Mendelssohn's G minor concerto, entrusted me with the revision of the fork which I had then raised to C 540 at 68° (Equal A 454). No new forks vere, however, issued, as the old fork was etter for the average temperature, although, ccording to recent experience, still sharp for 9° F, for which A 450 (Equal C 535·14 just C 40) would be correct. A 59° F $= 435 + \frac{3}{5}$ qual semitone A = 450; A 68° F $= 439 + \frac{3}{5}$ qual semitone A = 454 or equal C = 540, his fraction of the semitone being the actual lifference.

From 1850, Broadwood's tuners had three orks—Vocal C, 518; Medium C, 530; and Philarmonic C, 538. By 1885, the medium ad become of little use, being rarely asked or. All this shows that the general average itch continued to rise. Indeed, Mr. Blaikley, hose knowledge of wind instruments is very reat, states that in the North of England, rass bands are not content with philharmonic, ut still seek a higher pitch. However, it is ortunately not so with our orchestras or the usical public in London. Lissajous, as I ave said, was responsible for the standard ork of the French pitch, deposited at the onservatoire in Paris. On the authority of he organ builder, the late Cavaillé-Coll, we earn that he determined it by means of the siren riven by Cavaillé-Coll's bellows of constant ressure. The siren is a perforated disc set in otation by a stream of air and puffs of air assing through the holes set up a musical ound—rather a continuous unmusical sound, or it is not pleasing—the pitch being accordo the number of such puffs in a second, as re recorded by a counting apparatus. The ccuracy of the siren has always been affected y the uncertainty of the velocity of the driving ower. Years ago, before I became associated ith Dr. Ellis, in the determination of musical itch, the then Astronomer Royal, Sir George iry, proposed to me siren experiments with a pindle he had invented of constant pressure. hose experiments did not take place, and availlé-Coll certainly anticipated him. But he Paris standard fork is not quite correct, eing out by nearly a single, or half a bration a second, and Cavaillé-Coll was, I elieve, the first to call attention to the rror. I measured it myself, armed with verified fork by Kammen of A 439·5 in 878, and recorded the pitch as A 435·4 ince then the eminent acoustician, Dr. Koenig f Paris, has devised a very ingenious tuning-fork clock, and has proved this standard fork to be, at 15° Centigrade (59° Fahr.) A 435·45. Whether this fraction was an error of Lissajous, due to some very slight imperfection in the working of the siren, or the fork subsequently rose after tuning through the molecular change incident to filing, I cannot say; I incline to the latter explanation. Official French pitch-forks are in this country in the possession of John Broadwood and Sons: one sent by the Imperial Commission of 1859, which measures by Scheibler's tonometer, A 435·3, the other sent by the Council of the Universal Exhibition of 1867, measures A 435·5—the latter indistinguishable by the ear from the standard fork. Forks within ·5 are near enough for practical purposes, especially when we consider the important part played by the air temperature in modifying the pitch so that we rarely, if ever, in public performances with orchestra, hear the pitch according to the standard. I think it is remarkable that Lissajous could so nearly determine the Paris standard by the siren only. I conclude that he was assisted by the vibration microscope, of which he was the inventor. But at that time there was no certainty in any result claimed. Scheibler had passed away from notice, and his tonometer with him. It was my good fortune to meet by a happy accident with one of his tonometers, the one of which Dr. Ellis made such good use between 1877 and 1880. With his accurate work and what Dr. Koenig and others have invented and perfected, we are now certain of vibration numbers within very small fractions. But all determinations offered by physicists before Scheibler I think it is best to put aside as unreliable. Dr. Hullah's C intended for 512, was 525. Mr. Griesbach's A and C, published in 1860 by the Society of Arts, were 445·7 and 534·5, instead of 444 and 528, and earlier determinations, excepting Scheibler's, were probably more inaccurate. In fixing a standard it is desirable to restrict it to one note, an A, as on the Continent and with violinists everywhere; a C, as preferred in England and by organ builders; or a B flat, as at Kneller-hall, because this note is more suitable for the brass instruments of military bands: one note only, not two or three, on account of the confusion resulting from the use of an approximately just intonation by singers and skilled orchestral players, concurrently with the pianoforte maker and organ builder's equal temperament, the introduction of which in this country dates back only fifty years. No one with a conception of harmony can sing or play in any temperament by ear, while it is not possible to play in all keys on a key-board instrument without tempering, that is to say, making the consonant intervals such as fourths, fifths, thirds, and sixths, more or less impure, while preserving the purity of the octave. A, in equal temperament, is relatively sharper than C, and we have in determining a suitable note, say A or C, to remember that in equal temperament, starting from A, the C, and all keys with flats, will be perceptibly flat; and starting from C, the A, and all keys with sharps, will be perceptibly sharp as compared with just intonation, which, in our harmonic music, alone satisfies the ear. Pitch measurers of great exactness are the optical method, invented about 1878, by Professor Herbert McLeod and Lieut. R. G. Clarke, R.E., and the electrographic method of Professor Mayer of New Jersey, U.S. But these instruments are difficult to adjust and manipulate, and so is, in some measure, Dr. Koenig's tonometer clock, by which he has got results absolutely incontestable. But the tuning-fork tonometer already mentioned, invented by Johann Heinrich Scheibler, a silk manufacturer, of Crefeld, in Germany, 1834, is the readiest pitch-measurer for all practical purposes. Two forks are taken, which, when compared, are exactly an octave apart. A number of forks are interposed between the octave forks, beating roughly, each with its neighbour, four times in a second. When long enough tuned for the forks to have become permanent, the beats, which are equivalent to the number of vibrations by which the forks differ, are accurately counted, and their sum is the vibration number of the lower fork. The difficulty lies in the accurate counting, for which some practice is necessary, and a good chronometer, with a second hand, is also essential. The upper fork will, of course, be double the vibration number of the lower. Beats are the swelling and dying away of two musical sounds, the vibration numbers of which are unequal, although not differing considerably —at least for counting purposes. They denote that the sounds are not in step together. The diapason normal became law in France on the 1st July, 1859; the Report of the Imperial Commission having been published in the preceding February. It excited a great deal of interest in this country, and the Society of Arts acted with promptitude in seeking the opinion of musicans on the subject. A committee was appointed by the Council, and a report, drawn up by Dr Hullah, and issued on June 3rd, 1859, suggested a medium standard for England of A 440, just C 528, these being considered good vibration numbers for calculations; an idea however, of no practical utility. But had A 440 been adopted, and a standard fork tuned further action in this country might have bee hardly necessary, or easier than it is now, t obtain absolute conformity with France. A meeting was held in 1860, when the C 528 wa proposed, and its adoption maintained by Mr Cipriani Potter, against Sir John Herschel' C 512, the arithmetical vibration number a that time in great favour with scientific men because its foundation was one complet vibration in a single second of time from which it was computed by doublin for nine octaves. C 528 was adopted at th meeting, but instead of the just A 44 the equal temperament A 444. Mr. Griesbach a musician who had concerned himself wit experimental acoustics, was entrusted by th Society with the tuning of the forks, but th result, as already mentioned, was a failure His C 534·5, too sharp by 6·5 vibrations, is high pitch much liked by violinists, but is n so different from the Philharmonic C 538, a to compete with it. His A 445·7 was bette being only 1·7 too sharp—it is practicall Broadwood's medium pitch = C 530. Nothin more came of the Society of Arts pitch beyon the sale in music shops of forks stampe Society of Arts and tuned about C 535. Bu the French pitch, officially established, prove its adequacy by slowly and surely making wa in other countries. In 1869 the Society Arts tried through the Foreign Office t learn how far it had progressed, and fork were received from our Consuls abroad havin value for reference. But early in that yea 1869, Messrs. Novello and Co., the music publishers, then directed by the late Mr. Henr Littleton, boldly took the initiative and founde oratorio concerts, the first of which took plac in St. James's-hall on the 5th of Februar 1869, of which the late Sir Joseph (then Mr Barnby was conductor—the French pitch wa adopted and the wind instruments were bough for the performers. It was an experiment tha deserved a success it did not meet with. A similar fate appears to have attended S William Cusins's subsequent introduction French pitch into the Queen's State band. understand it has been given up and the hig pitch resumed. In the Music Division of th nventions Exhibition at South Kensington, in 85, on the Committee of which presided over the Duke of Abercorn (then the Marquis of amilton), I had the honour to serve, the estion of a lower pitch for the Exhibition was scussed. There was difference of opinion but was found impracticable to change from a ilharmonic A 452. An important public eeting was convened on the 20th of June, 85, by the Royal Academy of Music at St. mes's-hall, in consequence of a communica- n received from the Foreign Office, Sir eorge Macfarren presiding. The great ex- nse that would attend the altering of the mili- ry bands was discussed at this meeting, which s favourable to the adoption of the French ch, and it was resolved to approach the ke of Cambridge, then the Commander-in- ief, as to the feasibility of this alteration. is understood that His Royal Highness had objection provided there was no demand on the public purse. As even with altering brass instruments, a considerable sum uld be required to renew the wood, and the rinets are very important in military bands, was found nothing could be done, and thing was done.

The Society of Arts took the next step by erring to a committee comprising Sir Fredk. el, Sir John Stainer, Dr. William Pole, Dr. . H. Stone, Dr. A. J. Ellis and myself, the estion whether it was still desirable for the ciety to maintain the theoretical C 528. e report of this Committee, published in *Journal* of the Society, February 12th, 6, was as follows:—The Committee are of nion that the reasons which determined the ision of the Committee that in 1860 recom- nded the pitch since known as the Society Arts pitch (C 528) have now lost their force: ing that in 1860 the French pitch (A 435 (Equal) C 517·3) was only just established l was under trial, so that there was no ection to the proposal of another pitch in npetition with it. The French pitch has v been established (1886) for twenty-five rs and has been adopted in many other ntries, including Germany, Belgium, Italy l Austria, it having been formally adopted the Government of the last-named country recently as November last (1886) at the ernational Conference at Vienna. The nmittee think it would be a pity to cause a ism for the sake of a few vibrations, and t the Society would do well to abandon the h known as the Society of Arts pitch, and make public announcement of the fact. They also recommend that the influence of the Society should be employed in furthering the adoption of the French pitch." The notice in the *Journal* continues:—"At their last meeting the Council decided to adopt the recommendations of the Committee, and to give up any attempt to ensure the adoption of the pitch known as the Society of Arts pitch. The Council have adopted this course in the hope of clearing away what might otherwise be an obstacle to the adoption of a uniform pitch." What can now be said, after ten more years have passed since this very practical decision in the way of argument against the French pitch. It seems to me useless to consider Mr. Charles Meeren's Pythagorean A 432, derived from C 512, or Mr. Blaikley's G 100, suggested by him in an appendix to Captain Day's Catalogue of the Royal Military Exhibition, which took place at Chelsea in 1890, although that chimes in with a suggestion of my own published in the *Athenæum*, in 1878, to go back to the Paris A 448, with which Mr. Blaikley's G nearly agrees. If the French pitch, which has now conquered all countries but England, where the basis of music is harmony, what chance has any untried suggestion, however learned and practical it may be? Music should be a universal language, and we ought to agree that A shall be the same in England as in France, and in every other European country, in Russia and America. Let us accept the French pitch, even if at first it comes partially; I believe it will assuredly conquer, not to-morrow or next year; there are obstacles to be surmounted, notably the concert organs and the army pitch, but surmounted they will be in time. History teaches us the value of what we call a compromise pitch; science shows us how a standard can be secured. It is reasonable that the standard should be universal.

The last consideration I have to notice is that of temperature, which, as regards wind instruments, insists upon attention. I should say those wind instruments that have fixed lengths of tubing acting as resonators. The column of air in such a resonator is analogous to the prong of a tuning-fork with respect to vibration; but the air of the tube differs from the metal prong, which varies only with its bulk, and that but slightly, while the air becomes more rarified as the temperature increases, gaining in elasticity and vibrating therefrom in itself with greater rapidity. Mr. Blaikley, by long continued experimental trials of wind instruments, has established a tabulation for this increase which may be relied upon. He has been so kind as to lend me for this evening his diagram, showing the alteration of pitch for various temperatures, and including the flue pipes of the organ. For this, and the loan of the diagram of vibration numbers, as well as tuning-forks, I desire publicly to thank him. My own observations of the orchestra taken as a whole, and of the organ, practically agree with Mr. Blaikley's. I estimate the rise of temperature between 32° and 90° Fahr. may be expressed by the co-efficient of one-thousandth part of a complete vibration a second for one degree Fahr., so that for C 500 the rise per degree is ·5. But only the flue pipes of an organ, unaffected by the contiguity, the hands and breath, of the player conform exactly to this law. The only reduction likely to happen with the organ is when the air supply is derived from a chamber of much lower temperature. The organ is thus a thermometer. The pianoforte, a wire strung instrument, is not, and if it has to go with the organ must be tuned to the latter for a given temperature likely to prevail at the time of performance. In point of fact, a pianoforte falls slightly, although very slightly, with increase of temperature; according to a recent trial made by Mr. Blaikley and myself of a Broadwood Concert Grand, it is equal to ·25 in 10° Fahr. This, and the very slight fall of a tuning-fork under similar conditions, may, I think, be disregarded while dealing with the very much larger fluctuations due to the temperature of the air in resonators. Mr. Blaikley's diagram is enlarged from the tabulation published in the essay upon "Musical Pitch," written by him and included in the appendix to Captain Day's catalogue, already mentioned. According to it we may expect a rise for the note B flat in the treble clef at about Philharmonic pitch, for the ten degrees between 60° and 70° Fahr.

	Vibrations.
For the Flute and Obœ............	1·50
,, Clarinet	2·06
,, Cornet and Trumpet	2·45
,, French Horn and Trombone.	2·88

The mean of these instruments being 2·60, but adding the tubas, large brass instruments :—

	Vibrations.
Euphonium	3·16
Bombardon	3·50

the mean of the full wind band is 3·16; Mr. Blaikley's co-efficient for the organ is 5·04.

As I prefer to deal with the note A in the treble clef, as that has been chosen for th
French standard. I will transpose the co
efficients for the orchestral wind band accord
ing to an equal semitone to 2·45; for th
military, to 3·00; and for the organ, to 476·
Assuming that the pianoforte, an instrumen
unaffected by the contiguity of the player
should be tuned to agree with the organ, an
that 20° C = 68° Fahr. represents the averag
concert-room pitch, and also being tolerabl
sure of the practical accuracy of my co
efficient, I had tuning-forks made by Valantin
and Carr, of Sheffield, for A 439 as sufficientl
near 439·28, in advance of any orchestral c
organ trial that could be made; the increas
upon the French normal A, 435 of these fou
vibrations, being equal to the difference be
tween 15° and 20° C. (59° and 68° Fahr.).
was glad when Mr. Henschel suggested to m
a trial of his wind band at 68° temperature.
had a room prepared at this temperature, i
which the trial took place, and a pianofor
tuned to A 439 proved to be right. The ne
trial, which included the organ, was in th
Queen's-hall, in a public concert at about th
same temperature; organ, wind band, an
piano were in accord at A 439. Departu
from this temperature of 68° on either sid
would vitiate the intonation according to th
idiosyncracies of each wind instrument, th
organ of course being the worst. Do we n
see in the relative size of the wind instrumen
the cause of a varying rise or decline in pitch
It is in the temperature of the player's brea
having a greater influence over the small
than over the larger instruments.

We may regret that the French Commissio
did not fix their grade of temperature at 20° i
stead of 15° C. They could then have advant
geously fixed the normal diapason at A 44
as Scheibler five-and-twenty years before h
suggested. A 435 at 20° C would have be
too low, although that vibration number a
temperature has been accepted, at the instan
of the Honourable Levi Fuller, of Vermon
Massachusetts, by the Pianoforte Mar
facturers' Association of New York, for
international standard. The variation
the tuning-fork has here been consider
only, but is of slight importance when co
pared with the wind band and organ. If
low standard is accepted in this country let
abide by the French A 435 at 15° C, the pit
now recommended by the Society of Arts, a
adopted by the Philharmonic Society. V
shall then be in accordance with the Contine
of Europe.

DISCUSSION.

Mr. F. W. **Fletcher** complimented Mr. Hipkins the excellence of his paper. One great difficulty the present high pitch was painfully felt in nateur choruses, where the tenors were carried far ove their natural registers; and Handel and ozart could never have intended to inflict so much rture on the performers of their music as was iavoidable at the present day, and as long as the tch remained as it was. The lowering of the pitch ould, he felt sure, produce a grander and fuller ne in choral singing than the present practice of ertraining the voices. He thought that Mr. ipkins was doing a good work if even he only ssened the difficulty in producing an adequate per- rmance of the works of the great masters by the ices at command.

Mr. J. S. **Curwen** was exceedingly glad to find that r. Hipkins was in favour of the French pitch, and thought that was a practical compromise in which ey could all unite. The Tonic Sol-fa College passed esolution several years ago in favour of the French ch, and had thrown all the influence it possessed o that scale. He mixed a good deal with amateur yers and singers, and knew the intolerable con- ion that prevailed. Why not, then, go for an ernational standard, which was especially neces- y in a free-trade country. A self-supporting ntry like America could have any standard it ed, but a country like England, that imported nos, wind instruments, reed organs, harmoniums the million, must have an international standard, else there would be an enormous amount of con- ion. The only people for whom he felt sympathy e the players of the wood wind instruments in orchestra, who would have to buy new instru- nts, and he would willingly subscribe to a fund to ble them to do so. No doubt there were differences, when the end was good such things must be ust aside in the onward march of progress. Other ntries must have had the same difficulties and e through the same trouble, but change had been omplished in France, Belgium, and Austria. The nt of attack should be the War-office, and he ed the Society of Arts, which had done such le service in the matter already, would bring liamentary influence to bear to alter the pitch of military bands. When that was done the organs ld have to follow, and the rest would be easy.

Ir. **Jacques** said Mr. Robert Newman, of the een's Hall, broached a scheme such as Mr. Curwen mentioned for providing a fund to replace hestral instruments, but he was afraid it would not taken up. He was very anxious to start some- g of the kind if there were any chance of success.

Ir. **Blaikley** said he had nothing to offer in the of criticism on the paper, but might perhaps emphasize some points. He might first remark, however, in reference to what Mr. Curwen had said that the circumstances of this country were not quite the same as obtained in France or Belgium. The British Empire being so widespread the conditions with regard to military bands and the Indian army establishment were something peculiar, and certainly complicated the matter from the point of view of the War-office. Regiments went to India and Canada, and were there some years. The other day a regiment came home which had been abroad 17 years, so that if the pitch were altered at home during the next six months, the work would be only half done. With respect to attacking the War-office through Parliament, he would not venture to offer any opinion; but there was another point of at least equal importance, and that was the condition of the organs throughout the country. When the conference on this subject was held at the Royal Academy of Music, under Sir George Macfarren, the question was put to instrument makers whether they were prepared to make instruments of French pitch, or any standard that might be decided upon? The answer naturally was, that they were prepared to make them of any pitch desired; but the more important question is, whether the owners of existing instruments are willing to go to the expense of alteration. If the great organs were altered to-morrow, instrument makers would be obliged to adopt the same pitch. It was a question for the custodians of the present great organs whether the proposed pitch should become in any sense national. It was certainly a great advantage to have had this paper from Mr. Hipkins, who had been so long in actual touch with this subject, and spoke with knowledge at first hand. Although there was no strictly official pitch in England, it was worth noting that the Philharmonic pitch had been practically stable for about 50 years, and no doubt Mr. Hipkins himself was largely to be credited with this result. But while the pitch had been stable in all the best orchestras and military bands, the generally popular pitch in the country, which fifty years ago was distinctly below the Philharmonic—often very much below—was now, if anything, rather higher. He constantly came across instruments which were distinctly higher than the Philharmonic pitch of 1852, and if they attempted to bring it down they were met with the remonstrance from the owners that they liked to be sharp; so that the popular pitch had overpassed the only one which had any claim to be called a standard. And the causes which led to this were still in operation, being based upon natural laws. Unless this was clearly understood in the laying down of any fresh standard, difficulties would constantly arise. A society like the Philharmonic would keep the French pitch, but the upward growth would still go on elsewhere unless great care were taken in defining the standard. The temperature must be carefully defined, or everything would be at sea. Take two men with clarionets, one tried his instrument with a

standard fork in a cool room, say at 50° F., and found it right, the other tried his with the same fork at a temperature of 70° F., and found it right; each would feel certain his instrument was of standard pitch, but if they played first and second clarionet side by side, they would not be in tune together. An allusion had been made to a proposition put forward by himself, some time ago, for adopting a pitch closely agreeing with the Society of Arts C, as actually made. That happened to coincide with a basis of 100 vibrations for G on the first line in the bass clef, which seemed to be useful. Many instruments were made to that pitch, and many of them had since been slightly raised to agree with the Philharmonic C, and in being made higher had suffered rather than otherwise, and it appeared to him that if they could be reduced again it would be a practical and useful compromise between the highest pitch existing and the French pitch, many singers thinking the latter rather too low. At any rate existing instruments could have been adapted to it, and it would not have frightened the War-office so much as a complete renewal of instruments. But he agreed with Mr. Hipkins that at the present day it was not practicable, and he should say no more about it. Mr. Hipkins had spoken of fixing the A only as the standard, but the C must not be left undetermined. It must be clearly defined that the C fork should be in a certain temperament with the A; the temperament must be laid down as well as the temperature. The only practical temperament for wind instruments was equal temperament. He knew full well that players naturally played a just intonation. An orchestra would be unendurable playing in equal temperament in slow and sustained chords. They played in just intonation, but they could not do that in any key required, unless the instruments were designed on equal temperament. The influence of temperature on pitch was shown on the diagram. The greatest variation occurred on the organ, and the reason for the difference between organs and orchestral instruments in this respect was not generally understood. In the flue pipe of an organ the variation followed the law of velocity of sound, as influenced by the elasticity and density of the air at various temperatures; but in an ordinary wind instrument the conditions were modified by the breath. Assuming a number of instruments and an organ all being played in a room at a temperature of 98° Fahr., the temperature of the breath, and all in accord, when the room cooled, the organ dropped in pitch, according to the laws he had referred to. The other wind instruments also dropped in pitch, but in varying degrees; the air in the room being cooler than the breath cooled them to some extent, but not altogether; the smaller instruments —the flutes and clarionets—dropped least, because, when warmed by the breath, the casing of the instrument maintained a considerable amount of internal warmth; and, although warmer at one end than the other, the average temperature was
always higher than that of the air in the room, where
the average temperature of the organ pipe was n
In the case of the large brass instruments, the e
ternal air had more influence, and the breath h
less, especially as they were not in such constant us
and thus the variation in this case was midway betwe
the organ and the small wood wind instruments.
range from 40° to 80° Fahr. was not at all uncomm
between a cold morning and a summer afterno
and that would cover the difference between t
Philharmonic and the French pitch. This show
the necessity of taking temperature into considerati
in fixing the standard. There was one other po
on which he could not give any decided opini
which might be interesting for musicians and phy
ologists to consider, and that was the possible eff
of a change of pitch upon the perception of the r
of movement, or *tempo*, of a musical phrase. T
difference between Philharmonic and French pit
was about as 104 to 100, and a given note of sa
quarter second duration would impress the ear w
26 vibrations in Philharmonic pitch, as against 25
normal pitch. The question suggested is, therefo
whether a passage marked metronome 104, and intend
for Philharmonic pitch, would have its intended eff
better preserved when played at French pitch, if
metronome mark were changed to 100, so that the sa
number of vibrations should reach the ear in each ca

Mr. HIPKINS, in reply, said the object of
paper had been to obtain, if possible, a unifo
standard of pitch, and also to show that that stand
was always varying according to the temperature,
that an orchestra was, as a rule, always sharper th
the standard, because it was in a warm room wit
great many people; and even when the weather
cold the players were warm, and their breath warm
the air in the wind instruments, and the violins h
to play, and the singers to sing with them. Th
would be departing a long way from the Fren
pitch if they attempted to adopt Handel's,
would be only giving them a great deal of trou
for nothing, for he was sure no one would accep
The greatest thing which had yet been done towa
the adoption of the French pitch was the alteratio
the organ in the Queen's-hall. In future orato
would be performed there at French pitch, an
might come to pass that some of the other great org
at the Albert Hall, at Manchester, and elsewh
might be altered also. About the Army he could
say much, and was rather inclined to suggest that
new pitch might be adopted everywhere else f
and let the Army follow afterwards. As to e
temperament, what Mr. Blaikley said was perfe
true, wind instruments must be made in equal t
perament, but when so made the players in some
played them in just intonation whenever they co
Violinists played in just intonation if they were sk
and no one could sing in any other way if they t
He could not say much about the curious ques
raised by Mr. Blaikley. He knew that if a piano

ined to French pitch it did not injure it at all; it unded a little fuller, and it changed its character a tle. If you tuned it up to Philharmonic pitch it ecame more brilliant, struck the ear as being mething sharper, to many more agreeable. But wever agreeable a high pitch might be his object as to show that there should be one standard, that should be the same in London, New York, St. etersburg, or anywhere else. The change required as not so great as many people thought, it was only o-thirds of a semitone in the forks, and in the chestra three-fifths. With reference to Mr. Curen's statement that for some years past the tonic l-fa societies have adopted for their pitch C 517·3, would point out that this C, being an equal minor ird from A 435, is evidence in favour of the adopn of A as the standard note, and no other, for asmuch as the tonic sol-fa choirs sing in just intonan, their A is = 431·1 and not the French A.

The CHAIRMAN, in proposing a cordial vote of anks to Mr. Hipkins, said he was glad to find that ey all seemed to agree that it was very desirable to ve one uniform pitch. In his connection with the oyal Academy of Music, he had always felt that it as a positive cruelty to young singers to train their ices at so high a pitch. It was not fair; it was ne in no other country, and he was sure that glish voices must suffer from it in future years. is was brought home to him very forcibly last ar, when they had a performance at the Academy "Cavalliera Rusticana;" every B flat in the ior part had to be sung by the young gentleman, o sang it exceedingly well, as B natural, which was at no tenor in Italy would be asked to do, or Covent-garden. It was this which determined n to throw whatever influence he possessed in our of adopting the French pitch.

The vote of thanks was carried unanimously, and meeting adjourned.

Correspondence.

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IE REPORT OF THE ROYAL COMISSION ON SECONDARY EDUCATION.

The Rev. J. O. BEVAN, M.A. (President of the vate Schools' Association), writes:—I cannot ollect a paper which departs so far from a dignified tement of facts and conclusions, or which introes so much heat and acrimony as that delivered Mr. Macan on Wednesday last, dealing with the port of the Royal Commission on Secondary ucation. A great part of the paper is devoted to indictment of private schools and to insinuations ected against the Private Schools Association. ting out of consideration the unwritten law that n attack is contemplated some notification of the ntion is conveyed to those who are interested, I uld have taken it as an act of courtesy if Mr. Macan had given me an idea of the line he intended to take, especially as reference is not obscurely made to myself under the designation of President of the Society referred to. You could not permit me through the medium of a letter to traverse the statements to which I object, but I am perfectly willing to bring into the true light the elements that are unworthily represented in the paper. This I should be prepared to do on general educational grounds, or without any offensive personal references, and with due regard to the delicacy and complexity of the various interests involved. One or two illustrations may be permitted of statements as unfair as they are invidious. It is alleged that the College of Preceptors appear to desire the passing of a Registration Bill simply "to furnish a refuge for the destitute." I am surprised that a member of the Council of the College present did not protest against that statement. "Every man for himself and let us swindle our neighbours," is said to be the farmers' motto. Again, in another part, "The farmers, whose motto is now, 'Dig we cannot, to beg we are not ashamed;' the eminent Q.C.'s, fearing that, with a further spread of education, they will find their occupation gone, will no doubt do what they can to perpetuate that educational chaos upon which they have so far flourished." (!) Once more, "the irresponsible frivolity which characterised the Conference at Oxford." Permit me to furnish two illustrations of the illogical nature of some of Mr. Macan's statements. On p. 310 he contends that "private schools have no business to exist at all." But his concluding words declare the safest policy, and the only possible one, is to vote for "the Report, the whole Report, and nothing but the Report." But what says that Report about private schools? Does it recommend their extinction or deny their right to exist? Not at all; and I accentuate its conclusions the more, inasmuch as Mr. Macan has indicated that several of the Commissioners, notably Mr. Sadler, Mrs. Bryant, Professor Jebb, and Mr. Lyttleton found their enthusiasm for private schools cool in consequence of the experience gained during the enquiry, though I should judge he would be scarcely admitted into their confidence. But what is the unanimous declaration of the Commissioners? *Vide*, vol. I. p. 274, "We are far from desiring to see secondary education pass wholly under public control, and into the hands of those who are practically public servants, as elementary education has done; and we believe that where proprietary or private schools are found to be doing good work, it would be foolish as well as unfair to drive them out of the field." Again, vol. I., p. 292, we read, "So far from desiring to displace or even to weaken such schools as these, we trust that some of the measures may tend to stimulate and improve them. They must be allowed to subsist, &c." Thus, whilst Mr. Macan thinks that private schools are an abomination, and should be swept away by the besom of improvement, he incites all persons to vote for a Report which aims at giving these schools an assured position, and a more conspicuous part in the future of education. Furthermore, on p. 308, Mr. Macan declares "We are here met with the one proposal of the Commission, which cannot and will not pass into law, and that is the power of demanding a rate." I need hardly say this is a crucial point, referring to a most important provision. Yet our infallible guide declares that we are to support the Report, the whole Report, and nothing but the Report, containing, at the same time, a provision which cannot and will not—*i.e.*, ought not to—pass into law! In a matter affecting the interests of so many persons, and of the public at large; requiring, as it does, such delicate treatment and consideration to win the way to a solution of the problem which all right-minded persons would desiderate, what I have said tends, I think, to make it clear that we shall need a wiser and better-informed guide than Mr. Macan; and it is unfortunate that the subject has been brought before the Society in such a way as wantonly to insult and wound the feelings of the friends of education.

55, Gunterstone-road, West Kensington, W.
Feb. 24, 1896.

Mr. J. S. Thornton, (83, Fairlop-road, Leytonstone) writes:—Mr. Macan, in his paper last Wednesday, gives no references for the quotations he makes. I must therefore ask you to allow me to say that the quotation he gives on p. 310, col. 2, was from a lecture entitled "State Aid to all Efficient Schools alike: how it works in the Secondary Schools of Denmark," which is to be found both in the *Educational Times* for last month, and, in a form slightly more correct, in a pamphlet reprint issued by Messrs. George Philip and Son. As the responsibility of that deliverance rests with myself alone, I have left three copies of it in the Secretary's office, with the request that two of them may be placed on the library table, in order that members of the Society may judge for themselves both how far the quotation is correctly made, and, generally, whether Mr. Macan has been successful in his description of the aim and contents of my paper. I have also forwarded to the Secretary two numbers of the *Oxford University Extension Gazette*, one for September, 1894, and the other for April, 1895, which contain two papers confirmatory of my position. The first deals with "Danish Peasant Schools," and the second with "The Beginnings of Local Examinations."

Obituary.

Rev. Horace Waller.—The Rev. Horace Waller, who died on the 22nd inst, at his residence, East Liss, Hants, at the age of 63, had been a member of the Society of Arts for over twenty years, an he was at one time a very constant attendant at th meetings. In January, 1875, he took the chair an delivered an address at the opening meeting of th African Section, and on March 9th of the same yea he read a paper before this Section on "Livingstone' Discoveries in connection with the Resources of Eas Africa." He went to Africa in 1861 in connection wit the founding of the first branch of the Universitie Mission to Central Africa in the regions that ha just been explored and opened up by the united effort of Dr. Livingstone and Sir John Kirk. Mr. Walle was not then in orders, but he travelled out and afte wards worked with Bishop Mackenzie, being assoc ated for some time also with Dr. Livingstone in t Zambesi and Shiré districts. Returning to Englan on the death of Bishop Mackenzie, Mr. Waller to orders and soon began to devote a large part of h energies to opposing the slave trade, an oppositi which became one of the chief objects of his li When Mr. H. M. Stanley succeeded in discoveri Livingstone, the latter's voluminous journals we intrusted to the hands of Mr. Waller for publicatio and were given to the public in two large volumes 1875. The intimacy between Mr. Waller and t late General Gordon was of a very close and co fidential kind. Mr. Waller had been rector Twywell (Northamptonshire) since 1874. Befo that he had held a curacy at Chatham, and he had f four years been vicar of Leytonstone. Last year M Waller resigned his living at Twywell and removed the more temperate climate of South Hants.

General Notes.

Keats Memorial Tablet.—The tablet to t memory of the poet Keats, erected by the Society Arts on the house in John-street, Hampstead, n named Lawnbank, was unveiled on Saturday aft noon, 22nd inst., by Professor Hall Griffin. T house originally formed two houses, named We worth-place, and Keats lived in one of them bef he left England for Italy, where he died on 2 February, 1821. February 23, 1896, falling on Sunday, Saturday was chosen as the nearest date the 75th anniversary of the poet's death. Ab twenty years ago a distinguished resident at t house was Dr. Sharpey, the eminent physiologi and for many years secretary of the Royal Society

The World's Wine Production.—The *Mo teur Vinicole* has recently published a statem showing the wine production of the various countr of the world. From this statement it appears yield in France amounted in the years 1895 and 1 to 587,127,000 gallons and 859,162,000 gallons spectively; in Algeria to 83,549,000 and 80,124, gallons; Tunis, 3,956,000 and 3,936,000; It 469,555,000 and 539,000,000; Spain, 379,500, nd 528,000,000; Portugal, 43,890,000 and 3,000,000; Azores, Canaries, and Madeira, ,620,000 and 2,640,000; Austria, 66,000,000 and 8,000,000; Hungary, 63,030,000 and 46,103,000; nd Germany, 80,190,000 and 110,000,000 gallons. n Turkey and Cyprus the production last year mounted to 52,800,000 gallons, and this compares ith an average yield of 40,000,000 gallons. In ulgaria the yield was 26,400,000 gallons; Servia, 7,600,000; Greece, 35,200,000; Roumania, 8,640,000; Switzerland, 27,500,000; the United tates, 89,700,000; Mexico, 1,980,000; Argentine epublic, 29,700,000; Chili, 33,000,000, Brazil, ,700,000; Cape of Good Hope, 2,420,000; Persia, 94,000; and Australia, 3,300,000 gallons.

GAS AND ELECTRIC LIGHTING IN BERLIN.—erlin is probably one of the best lighted cities in urope, and its consumption of both gas and elec- ricity is far above the average. According to a ecent German trade review, the central electric tations in Berlin supplied electricity for 5,673 arc mps, 121,000 incandescent lamps, and 667 motors, nd the annual consumption of gas is 102,000,000 ubic metres. The lighting of the streets by gas ates from 1826, so that Berlin was some thirty ears behind England and nine years behind Paris. was an English company — the Imperial Gas ssociation—which from January 1st, 1826, took ver the street lighting for a period of 21 years, oth gas and oil lamps being used. At the expira- on of this term the town itself took the lighting in and, and no trouble has, especially during the last years, been spared to keep the lighting of Berlin the front. Berlin, which now boasts about ,725,000 inhabitants, is lighted by 25,332 gas mps; of these 18,725 are ordinary burners, 6,003 re Bray burners, 55 Auer burners, and 549 Siemens. erlin has five gas works, with 3,005 retorts and 21 eceptacles. The number of petroleum lamps for reet lighting is about 1,200. The use of electric reet lights dates from 1880. The authorities were ot by any means in favour of electric light, but their bjections were overcome, and in 1882 one or two of e principal thoroughfares were lighted by elec- ricity. Six years later a move was made, the electric ght being adopted for some of the most important reets and places. Berlin has now five central ectric stations, in addition to which there are some o private installations. This brings up the number lamps to 10,537 arc and 203,532 incandescent mps.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 4.—"Röntgen's Photography of the In- sible." By A. A. CAMPBELL SWINTON. PROF. AMES DEWAR, M.A., LL.D., F.R.S., will preside.

MARCH 11.—"Peasant Life and Industries in Ireland." By PROF. A. C. HADDON. THE DUKE OF ABERCORN, K.G., will preside.

MARCH 18.—"Bahamas Sisal Industry." By DR. D. MORRIS, C.M.G., M.A. GENERAL SIR HENRY W. NORMAN, G.C.B., G.C.M.G., will preside.

MARCH 25.—"Our Food Supply, as affected by the Farming of the Future." By PROF. JAMES LONG.

Papers for evenings, the dates of which are not yet fixed:—

"Dairy Produce." By GEORGE BARHAM.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"Early English Organ Writers." By BURNHAM HORNER.

"High Explosives and Smokeless Powders." By **HUDSON MAXIM.**

"Fruit Drying or Evaporation." By EDWARD W. BADGER.

"The Perfected Photochromoscope and its Colour Photographs." By F. E. IVES.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant - Governor of the North - Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E. The EARL OF DUNMORE will preside.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of April 23, and May 14 will be held at the Society of Arts; those of March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

MARCH 10.—"English Book Illustrations, 1860-70." By JOSEPH PENNELL.

APRIL 14.—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

MARCH 3.—"The Commercial Prospects of English East Africa, and British Central Africa." By G. SCOTT ELLIOT. SIR JAMES CRICHTON BROWNE will preside.

APRIL 21. — "Madagascar." By CAPTAIN PASFIELD OLIVER. MAJOR MARINDIN, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c." Lecture III.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. M. Thomson, "The Chemistry of Certain Metals and Their Compounds used in Building, and the Changes Produced in Them by Air, Moisture, and Noxious Gases, &c." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Prof. Long, "The Utilisation of Derelict Land."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, United Service Institution, Whitehall, S.W., 7½ p.m. Mr. T. H. Brigg, "The Mechanics of Horse Haulage."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Messrs. Cross and Bevan, "Artificial Silk."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. A. J. McMillan, "Manitoba: its Capabilities and Requirements."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. A. A. Hudson's Paper, "The Conditions of Building Contracts."

British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper by Dr. Guppy.

Medical and Chirurgical, 20, Hanover-square, W., 5 p.m. Annual Meeting.

TUESDAY, MARCH 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. G. Scott Elliot, "The Commercial Prospects of English East Africa and British Central Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Covering of Plants and Animals: its Structure and Functions." (Lecture VIII.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. William Henry Wheeler, "Littoral Drift in Relation to River Outfalls and to Harbour Entrances."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. P. L. Sclater, "Remarks on the Divergences between the 'Rules for naming Animals' of the German Zoological Society and the Stricklandian Code of Nomenclature." (To introduce a Discussion on "Zoological Nomenclature.") 2. Graf Hans *v.* Berlepsch and J. Stolzmann, "The Ornithological Researches of M. Jean Kalinowski in Central Peru." 3. M. Adrian Dollfus, "West Indian Terrestrial Isopod Crustaceans." 4. Mr. G. E. H. Barrett-Hamilton, "The Discovery of Remains of the Norway Lemming (*Myodes lemmas*) in South Portugal."

WEDNESDAY, MARCH 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. A. Campbell Swinton, "Röntgen's Photography of the Invisible."

National Indian Associatiation, East Conference Hall, Imperial Institute, S.W., 4 p.m. Mr. M. A. Turkhud, "Kathiawar and its People."

United Service Institution, Whitehall, S.W., 3 p.m. Capt. J. M. Grierson, "Staff Rides."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C. 7¼ p.m. 1. Adjourned Discussion on Mr. E. Carpmael's paper, "Aiding and Abetting in Infringement." 2. Mr. J. Imray, "Recent Dicta a to Amendment of Specifications."

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MARCH 5...Royal, Burlington-house, W., 4½ p.m

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Prof. Gusta Gilson, "Segmentally Disposed Thoracic Gland in the Larvæ of Trichoptera."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs H. B. Dixon, E. H. Strange, and E. Graham "The Explosion of Cyanogen." 2. Mr. H. B Dixon, "The Mode of Burning of Carbon." Messrs. H. B. Dixon and J. A. Harker, "Th Detonation of Chlorine Peroxide." 4. Mr. H. J. H Fenton, "Constitution of a New Acid Resultin from the Oxidation of Tartaric Acid."

Society for the Encouragement of Fine Arts, Conduit-street, W., 8 p.m. Mr. E. D. Webb "Our Rude Forefathers 200—600 A.D."

Royal Institution, Albemarle-street, W., 3 p.m. Re William Barry, "Masters of Modern Thought. (Lecture I.—Voltaire.)

Camera Club, Charing-cross-road, W.C., 8¼ p.m 1. Mr. T. Dallmeyer, "The Bergheim-Dallmeye Lens." 2. Mr. H. L. Aldis, "The Dallmeye Stigmatic Lens."

FRIDAY, MARCH 6...Royal Institution, Albemarle-street, W 8 p.m. Weekly Meeting. 9 p.m. Mr. A. Binnie, "The Tunnel under the Thames at Blac wall."

Geologists' Association, University College, W.C 8 p.m. 1. Mr. A. E. Salter, "'Pebbly Gravel from Goring Gap to the Norfolk Coast." Mr. Frederick Chapman, "Some Pleistocen Ostracoda from Fulham."

Junior Engineering, Westminster Palace Hote S.W., 8 p.m. Mr. Charles H. Fletcher, "Co Handling for Steam Generation."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-squar W.C., 8 p.m.

SATURDAY, MARCH 7...Royal Institution, Albemarle-stree W., 3 p.m. Lord Rayleigh, "Light." (Lec ture III.)

Journal of the Society of Arts.

No. 2,259. Vol. XLIV.

FRIDAY, MARCH 6, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

MR. HARRIS'S CANTOR LECTURES.

In consequence of the pressure of unforeseen business, Mr. H. GRAHAM HARRIS finds himself quite unable to deliver the course of Cantor Lectures on "Refrigeration," announced for delivery on March 9, 16, and 24. These lectures are therefore unavoidably postponed until next session.

FOREIGN & COLONIAL SECTION.

Tuesday, March 3, 1896; SIR JAMES CRICHTON BROWNE, M.D., LL.D., F.R.S., in the chair.

The paper read was—"Commercial Prospects of British Central and East Africa," by G. Scott Elliot, M.A.

The paper will be printed in a future number of the *Journal*.

PROFESSOR THOMSON'S CANTOR LECTURES.

On Monday evening, 2nd inst., PROFESSOR J. M. THOMSON, F.R.S.E., delivered the third and last lecture of his course on "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c."

On the motion of the CHAIRMAN (Mr. Francis Cobb), a cordial vote of thanks was ccorded to the lecturer for his valuable course f lectures.

The lectures will be published in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the ward of the Albert Medal for 1896 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 11th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir William G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures and Commerce, through the world-wide influenc which his researches and writings have had upon th progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "fo his discovery of the method of obtaining colourin matter from coal tar, a discovery which led to th establishment of a new and important industry, an to the utilisation of large quantities of a previousl worthless material."

In 1891, to Sir Frederick Abel, K.C.B., D.C.L. D.Sc., F.R.S., "in recognition of the manner i which he has promoted several important classes c the Arts and Manufactures, by the application c Chemical Science, and especially by his researche in the manufacture of iron and of steel; and als in acknowledgment of the great services he ha rendered to the State in the provision of improve war material, and as Chemist to the War Depar ment."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph Lister, Bart., F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery been generally promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., 'in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of he iron and steel industries."

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday evening, Januuary 28th; MAJOR G. E, W. MALET in the chair.

The paper read was—

STAMBOUL: OLD AND NEW.

BY RICHARD DAVEY.

I wish you to do me the favour of forgetting at you are in a lecture-room, and to imagine ourselves gathered together in some old ountry house, by the fireside, listening to e impressions of a friend recently returned om a visit to one of the most celebrated and urious cities in the world. You first begin to ealise that you are approaching the East hen you reach Pesth. I got there late, and ent to the "Hotel Continental," which, ough by no means the best in the city, was every way superior to any but the most expensive in England. When, early in the morn-g, I went out into the street, I missed my way, nd so found myself in a maze of old streets, hich, by their Oriental character, reminded e of the fact that some three centuries back, Pesth was for over 65 years in Turkish hands. The houses were without external windows, and evidently possessed courtyards after the Moorish style. I wandered about in this ancient quarter until I was getting quite tired, but I saw very few or no characteristic costumes. Everybody was in modern European dress. Suddenly I emerged from one of these old streets into the most magnificent thoroughfare I have ever seen—the Andrasse Strasse. Since the solution of the Hungarian question, amazing progress has been made throughout the country, and especially in the capital; and there is no street in London to compare with Andrasse Strasse. It is about twice as broad as Regent-street, and nearly half as long again, bordered by magnificent houses, hotels, baths, shops, and churches. Branching out of it in all directions are other noble thoroughfares and quays. A broad boulevard surrounds the town, and has a capital line of electric trams. This progress is the work of forty years, for very different indeed was the Pesth of the days when every English heart was with Kossuth and his cause. Liberty and good government have made Buda-Pesth literally the Chicago of Europe, a city of light and progress.

Sofia is another example of what liberty and a fair amount of enlightened government can effect in a few years. Before 1878 this town was a filthy illpaved semi-Turkish city. To-day it has magnificent streets, tramways, electric light, telephones, noble hotels and theatres, and yet fortunately its thoroughfares are still enlivened by brilliant Oriental and semi-Oriental costumes. On the third morning we approached Constantinople, and the guard came along shouting, "Stamboul," "Stamboul." Looking out of the window we saw nothing on either side but an absolute desert. One might have been going through Sahara. It is impossible to imagine you are entering a great capital.

There are visible merely a few huts, a few trees, and plenty of brown earth; not a human being in sight. Presently we beheld the outline of the castle of the Seven Towers. Then on the Marmora side we noticed the ruins of the walls mostly overthrown to make way for the railway. Here and there a tower rising out of the sea and a picturesque ruin or so, but most of the glorious relics of the Middle Ages have been swept away to make room for this vandal railway. The railway station is a poor affair, scarcely worthy of a fifth-rate Italian city, but when you alight you find excellent public carriages awaiting you to take you over the bridge to Pera, where the hotels are situated.

Certainly my first impression of Constantinople was not favourable. It was cold and damp. The streets were almost destitute of the picturesque costumes which I had anticipated, and I was fairly startled by the enormous number of dogs. I knew there were a great many, but I had no idea they swarmed as they do, and, above all, I was ignorant of the terriffic howling which they keep up all night. This, together with the Betchi, or night watchman, who stamps a heavy iron pole upon the stones at intervals of half an hour throughout the whole night, managed to keep me awake until the early hours, when I fell asleep through sheer exhaustion. The landlord came to me next morning and asked if I would like to go up on the roof and see the view. It was a most lovely sight, and although it had been snowing in the night, I do not think in all my life I ever saw anything so enchanting as the view. The Sea of Marmora lay before me as blue as sapphire, and on its horizon rose the faint outline of the beautiful hilly Prince's Island, and far away, like a dim cloud, Mount Olympus was visible. Opposite was Scutari with its domes and minarets, and the trees indicating the English cemetery, where sleep so many Crimean heroes. Then towards the Black Sea sweeps the Bosphorus with its palace and village-lined shores. To the left the Seraglio point, with the irregular outline of the old palace of the Sultan. Then comes the dome and four minarets of St. Sophia, opening that stupendous procession of mosques which extends in picturesque confusion of dome and minaret across the summit of the seven hills which stretch from the Sea of Marmora to the Adrianople Gate. The foreground of this splendid panorama is rendered memorable by that grand tower of Christ which figures so conspicuously in all the views of Galatea. It was built by the Byzantines as a watch tower, and from its summit the guards were able to give the alarm in the event of one of those innumerable fires which have from time immemorial devastated Constantinople. It also served another purpose which is but little known. It seems that throughout the Byzantine Empire, in various conspicuous spots, similar towers were erected, on the lofty summits of which coloured lights were flashed from one to another. The various shades used had a distinct signification, and served as a sort of telegraph intended to warn the capital of approaching danger, thereby anticipating telegraphy by many centuries.

I must admit that the first glimpse of Constantinople diappointed me, but after a few days I was compelled to reverse my opinion. I began to appreciate its unique picturesqueness and its historic interest. Except in a few leading thoroughfares there is no attempt at pavement, and the streets may well be described as a series of filthy dust hills guarded by countless dogs who noisily dispute the bones and scraps of food they discover in the accumulation of rubbish. These dogs are of one breed and are, I am assured, the original of our collies. I was recently told by a great authority on dog matters that sometime late in the last century a Scottish gentleman, Captain Colley, visited Constantinople, and brought thence some street dogs which by dint of proper care developed into the beautiful dog called after him. Whether this is true or not I am not prepared to say, but at any rate the Constantinopolitan dogs, which are mostly yellow and black, are distinctly of the colley type.* They are not mongrels as they are frequently supposed to be, but of pure breed. They are exceedingly intelligent and docile, and never attack even a stranger excepting at night in the Turkish city proper, where they are well aware the Giaou has no right to penetrate once the sun has disappeared. Batches of these dogs guard certain streets and they are never known by any chance to encroach upon the domains of thei neighbours. They are said to be useful a scavengers, but I am persuaded that befor long modern improvements will have swep them entirely away, as has already bee the case at Smyrna, where now you do not se one of them in a day's walk, although a fe years ago they were quite as numerous in tha progressive city as in the capital.

Costume has fallen from the upper to th very lowest classes, and only mollahs an softas, priests and ecclesiastical students wear the turban. All the rest of the populatio sport the well-known red fez, which is very un becoming, and said to be fatal to the sight, a it affords no protection to the eyes in a climat the brilliance of which, when the sun doe shine, is exceptional, even in southern lat tudes. The women, however, still wear th yashmak and ferigee, but they have discarde for ever the yellow slippers, which were at one time so characteristic of Constantinople, and worn by the men as well as the women. A Turkish woman is not happy unless she is wearing a pair of patent leather shoes, which, as a rule, she thrusts into a pair of ill-fitting goloshes. Modern European carriages replace the delightful old *arabis* of former times, and you may live months in Constantinople without seeing a camel, these animals having been entirely banished since the introduction of railway communication. Thus the streets of what was once the most picturesque city in the world, as far as costume is concerned, are not to-day very much more remarkable in this point than modern Malta or Naples.

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* The original derivation of collie or colley is doubtf and various guesses have been made. Dr. Murray does n mention the suggestion in the text. Chaucer has *colle* the proper name of a dog.—*Ed.*

The modern Turk of the lower and middle classes cuts a ridiculous figure in our hideous costume; he does not know how to wear it, and, as a rule, never owns a single garment which fits him even respectably; indeed, I am sure that the greater part of his wardrobe is imported from London, Paris, Vienna, and Berlin, and that Constantinople at the present moment is the leading depository for the second-hand clothing of the rest of Europe. The ladies, however, are still very picturesque, and remind one of so many dominoes; and in summer their clothes are not only made of splendid silks and velvets, but they seem to have a special predilection for gorgeous colouring. Constantinople may well be described as the "city of the golosh." Be the weather ever so cold, so dry, so hot, or so damp, owing to the filthy condition of the streets, which, if they are not impassably muddy, are appallingly dusty; every man, woman, or child in the city—native or foreign—goes about with their feet shed in goloshes.

I shall never forget my first visit to the Sublime Porte, where I went in order to be ntroduced to his Highness the Grand Vizier. The first thing that attracted my attention was a huge pile of goloshes a couple of yards high, guarded by a very dirty attendant, who approached me with a view to secure mine, which he retained during my visit, returning hem at its conclusion in exchange for a piastre. I found the Grand Vizier to be a courteous gentleman some fifty years of age, dressed in a modern German-looking military uniform. His attendants were clad in exceedngly shabby frock coats and very dirty shirts, with no cravats, and their stained trousers hanging loosely about their legs completed about as seedy looking customers as it is possible to imagine. Seventy-five years ago, when a stranger went to the Sublime Porte to pay his respects to the second person in the empire after the Sultan, he was invariably enchanted with the stately ceremonial and the magnificent uniforms. He beheld the Grand Vizier dressed in white satin lined with ermine, and wearing upon his head an egg-shaped turban blazing with diamonds. He was surrounded by his officials in equally magnificent apparel, and a host of eunuchs and slaves whose dresses were scarcely inferior to those of their masters in sumptuousness of material and jewellery. However, the Grand Vizier retains some traces of the old Oriental system, for I had not been in his company five minutes before two mutes presented themselves and sat on either side of the door, watching all that transpired. These unfortunate beings who have been deprived of their tongues and had the drums of their ears perforated so that they can neither speak nor hear, are supposed to use their eyes all the better for these horrible mutilations, and to know if the stranger has any fell designs upon their august master's person. The Oriental prostrations and lowly obeisances on the part of the attendants, deprived as they are of their Oriental costume, struct me as ridiculous, not to say degrading; the fact being that their costume approaches them too closely to ourselves and to our own habits not to render the sight of their Oriental slavishness highly objectionable. What would seem natural from a man in a flowing robe looks abject and silly in an individual dressed in frock coat and trousers, or the tight-fitting uniform of modern Europe.

It was Sultan Mahmoud II. who ordained that his subjects should cast aside their picturesque robes for modern European dress, and at the same time he ordered that they should wear the fez so as to indicate their being Ottoman subjects. This was unfortunate, for the fez looks ridiculous surmounting a frock coat. It is quite true that the lower orders in Constantinople still retain their picturesque dress, and thereby prove of great value in the landscape. Once, however, you leave Constantinople and get as far as Broussa, colour in the streets predominates, the effect of which makes you regret all the more the absurd order issued by Sultan Mahmoud. Another fact connected with this costume is that, since the people are not educated up to modern ideas, whenever they break out into some barbaric habit engendered by centuries of a lower order of civilisation they look absurd. Nothing can be imagined funnier than to see a regiment of soldiers in tight-fitting German fashion endeavouring to go through the genuflections of the Mahommedan religion, which consists, as of course you know, in a series of gymnastics, ending by the devotee touching the earth with his forehead.

Another and more practical objection to this change in costume is the decrease it has caused in local trade. Constantinople had been in former years the great mart for native boots and shoes, mostly made of yellow leather. At present almost all the boots and footgear used by the entire population are brought ready made from Vienna and Berlin. In addition to the boots millions of goloshes are worn, and even the very poorest manage to own a pair of these very useful but distinctly ugly articles of footgear. As a matter of fact, since the loss of the European provinces, Constantinople has degenerated from a first to a tenth-rate commercial port. Pesth is now the chief market for Bulgaria and Servia, and so great has been the decrease in the commerce of Constantinople that the loss is not less than four millions a year on the wool tax in Bulgaria alone.

I suggest that the English Chamber of Commerce should examine into this matter, for it seems absurd that we, who produce quite as good indiarubber manufactures as Germany, should neglect so important a branch of trade. It is impossible to live in Turkey without a pair of goloshes, on account of the extremely dirty condition of the streets. Now there is no reason why we should not import these articles direct from England by sea whereby our goods ought to be sold considerably cheaper that those which have to perform the weary journey through Bulgaria and Servia. As a matter of fact English commerce in Constantinople is now almost effaced by that of Germany.

I now wish to describe in a few words the beauty of the various mosques and the objects of interest which many of them contain. Of these the most celebrated is the famous church of St. Sophia, the design of which is most admirably suited for the purposes of Divine worship. Although much smaller in actual size than most of the Gothic cathedrals, it is far more convenient than any one of them, since not less than 20,000 worshippers can see everything that takes place at the altar either from the pavement or upper galleries of this stupendous hall. I am glad that Mr. Bentley, the architect of the new Roman Catholic cathedral for Westminster, has made St. Sophia his particular study, and I hope that the construction of this building will lead to a fuller appreciation of the advantages of Byzantine architecture in ecclesiastical buildings. The other great mosques of Constantinople, known as the "Imperial," was built in imitation of St. Sophia, and is also worthy of study on account of its splendid proportions and the facilities it afforded for enormous congregations to see and hear whatever is passing in that portion of the edifice devoted to sacred ceremonies. Over a hundred mosques of Constantinople were originally Byzantine churches. These are as a rule small square buildings with a centra dome, and the majoriry of them are gorgeously ornamented with mosaics. None however, exceed in interest the church o the Chose-a-noir, known as the mosaic mosque on the walls of which still linger a series o mosaics of the 12th century, and not a few frescoes of exceeding beauty. The study of these frescoes would, I believe, reveal the origin o the art of Cimabue and Giotto, and, of course the other early Italian masters. The icons, o images, still existing in the Greek churches o Constantinople, were rescued in many in stances from older sacred edifices, when these were converted into mosques. Almost a these pictures are either scenes from the Ol and New Testaments or episodes in the live of the saints. They are brilliantly coloured somewhat in the style of Angelico, and upon golden background. Others, however, wer encased in silversmiths' work of the mos imposing description. In the church of S Peter, at Galatu, is still preserved a cele brated Byzantine icon, taken from the churc of St. Theodora. It is of great size, and on the faces, hands, and feet of the Virgin an Child are visible, appearing through a sort screen of elaborate workmanship, wrought i solid silver. I recommend the study of thes icons to all who are interested in early Italia art, on account of the evident influence whic they must have exercised on Gentile Bellin who painted for Sultan Suleyman, and who beautiful portraits of this Sultan and h celebrated wife, Roxalana, were presented b Sultan Abd-ul-Aziz to Sir Austin Layard, an are still in the possession of his widow, in h gallery at Venice. Another church, to whic I wish specially to refer, is that of SS. Sergi and Bacchus, popularly known as the little S Sophia. If anything, this church is mo perfect in its detail than its more imposin namesake. It was built by Justinian, and w used by the Latins until the conquest of t city by the Mahommedans in 1452.

The triple series of walls which surround the city date from the time of Constantine, and were rebuilt and restored by various emperors. They extend from the Golden Horn to the Sea of Marmora on the land side, and are amongst the most magnificent ruins in the world. Unfortunately they have suffered very considerably during the recent earthquake. Should Constantinople ever pass into other hands a great quantity of valuable works of art of the Greek and Byzantine periods would, I am convinced, be found. It must be remembered that the Byzantines brought from all parts of Asia Minor whatever time and the barbarians had spared, and that in the Hipprodome they accumulated many thousands of statues, not a few of which were by the greatest classical Greek sculptors—Praxiteles, Phidias, and others of equal renown. The Crusaders either smashed or carried away the majority of these masterpieces; but it is surmised that many were buried, and that if properly conducted excavations could be organised not a few might be recovered. The celebrated mausoleums brought down from Sidon are supposed to have contained the bones of generals in the service of Alexander the Great. The largest of these sarcophagi is one of the most beautiful works of art left to us untouched by time. It is of alabaster, and covered with bas-reliefs of the most exquisitely delicate workmanship, representing scenes from the battles between the Persians and the Greeks. The formation of his museum is due to Abd-ul-Hamid, and a ribute of admiration is due to him for the bold manner in which he has broken through the Mahommedan prejudices in not only granting permission for its foundation, but, what is still more surprising, for a school of art attached hereto, in which many of the ancient arts of he East are being revived with great skill nder the direction of the very able Hamdi Bey, its director.

It is impossible to conclude this paper withut some reference to the very unfortunate ondition of Turkey at the present moment. n approaching this subject it should be carelly borne in mind that the movement in rmenia is not as is usually supposed, of a urely religious nature, but is mainly political, nd I cannot but express regret at the indiscretion of the Armenian Committees in Engnd, and of that section of the Press which as allowed itself to be deceived in a great easure by their extravagant assertions. The urks are not naturally intolerant, but when excited they are tigers, and, unfortunately, everything has been done to irritate them, for it must be remembered that the denunciations against them and their chief are translated from the English newspapers into Turkish, and disseminated amongst the Mohammedan population by our numerous enemies in order the better to weaken our influence in lands where it ought to be paramount.

DISCUSSION.

The CHAIRMAN said they would no doubt all be inclined to blush for the mischief which the Crusaders did in the place which they were trying to save. It was always the way of the world, when men's passions were let loose the bump of destructiveness was let loose too. As an illustration he might call to mind the events which happened in Agra and Delhi after the mutiny, where most of the mischief was done by British soldiers, who destroyed the ancient monuments and picked the mosaics out in the mosques, exactly as the Crusaders did in Constantinople.

Mr. S. S. BROMHEAD said they no doubt all felt there was a considerable amount of discredit attached to this country in connection with the events in Armenia, and he should like to have an opinion from Mr. Davey, who knew the country so well, whether, as America had expressed her sympathies in the matter, it would not be possible for an English fleet to transport these wretched people, or the majority of them, from that country across the Atlantic, where there were vast territories unoccupied. It seemed to him that was the only possible way of giving them any assistance, because we could not go to fight for them, and if money was sent, as it had been, they were only robbed of it again.

Mr. DAVEY said he feared the scheme was not at all feasible. In the first place there were nearly 2,000,000 of Armenians, if not 3,000,000, and, secondly, the greater part of the number lived eight or ten days' journey from the coast, because communication in Asia Minor was extremely bad. It took seven or eight days to go from Trebizond to Erzeroum, although it ought only to take thirty hours by train. Again, he feared the presence of our ships of war in the Bosphorus would create such indignation that, before the Armenians got to the coast, they would all be massacred. The danger was that any sort of crusade should be got up in their favour. If such a thing were to take place, he was perfectly certain the Armenians, and all the Christian population throughout the country, would be killed within a fortnight. The unfortunate part of the whole business was that the Mohammedan population had got into their heads that we wanted to conquer them. Now the Mohammedan would not only die for his faith, but he lived up to it after his fashion. He did believe in the Koran, in his prophet, and in Allah. One should see their faces when at prayer, and the regularity with which they carried out the laws they were taught, to realise this. They were proud because they were a conquering people, and they had the arrogance of a conqueror; and you could not get that out of their heads. He did not particularly admire the Mohammedan religion, but it had done a great work. No doubt it would have to take its place among the shades of other departed creeds, perhaps in one centre, perhaps in two, but at present there was the formidable fact that it was the religion followed by countless millions of men, who all believed exactly alike. They lived in the same manner that they did when their prophet was on earth. If any fatal mistake were made now, they would see such a hydra raise its hundred heads that the imagination trembled to think of, and such massacres as one could not conceive possible. The Turks were not an effeminate people at all; they were a tremendous set of warriors; and although they might not have proper engines of war, they would fight like zealots or like madmen, because every Mohammedan who died for the green banner of the prophet thoroughly believed he would go straight to heaven.

Mr. THOMAS CHRISTY, having stopped in Turkey for some time, said Constantinople was one of the most impossible places; there was no means of doing anything, no means of instilling anything into the people. If you bought land and paid for it, and thought you were going to take possession, you could not go there twice. Even if you hired land for sporting purposes, you might go once, just at the time when you paid your money, but you could not go afterwards. There was no doubt the country was naturally one of the richest in the world, and, as far as could be found at present, the ground only wanted scratching, but there was no one to protect you, even while you scratched it. At a recent meeting of the Biblical Archæological Society, a gentleman who had a house in Jerusalem, said one tribe would go and try to get a nice little bit of land, and get a crop, and another tribe would wait until it was ripe, and then they would fight for their lives who should have the crop. Altogether, it was an impossible country.

Mr. DAVEY said all this was perfectly true. He could tell 100 anecdotes to illustrate it. He knew an English gentleman who purchased a number of valuable agricultural implements, spending between £2,000 and £3,000 upon them, and brought them over; but what did he do with them? They were all in the barn now. They were sold to a pasha, and he paid for them, but he could not get a Turk to use them, they all ran away from them in horror. It was the same thing all over the country, for the minds of the people were not above those of savages. The Koran had given them a certain amount of moral training, and, when left to themselves, they were hospitable, kindly, truthful, and, so far, honest. He must say he got on very well with the lower population, and used to go about the lowest parts of Constantinople with perfect freedom. He used to go to a *café* at the Adrianople gate, where the countrymen used to come, and he remembered on one occasion some Turks who had come a long way who had some food with them resembling curds and whey; they put some on a plate and offered him, and insisted on his taking it, and would not take a penny for it. They were a kindly, honest, sober people, but Mohammedanism had put a band of iron round their brains. They could not think, all thinking was done for them in the Koran.

Mr. CHRISTY thought it would be interesting to get it on record that the Armenians up to within quite lately had been the trusted servants of the Turks. This Sultan and the last Sultan thought they would have honest, respectable people about them, and they had Armenians. The Armenians in Constantinople and all through the country were the most respected class of the people. Why they had been massacred, as Mr. Davey had told them, was because through some political craze or another the Kurds had been let down upon them, and they had murdered them to get them away.

Mr. DAVEY said one thing which had not been pointed out was this. The Armenians had been a little prematurely educated in the cities where American Missions had been established. They had educated their pupils in too big schools, and the result was they talked too loudly and tried to do the young American. He had seen that himself. No doubt there was intrigue, he would not say from which country, but certainly it was a very mysteriou thing that the whole of Turkey was flooded wit revolutionary literature and pamphlets which came i by the cartload from Tabriz and Tiflis. Thes Armenians had certainly got to be rather cocky and they had been put at the mercy of th Kurds. The Kurds went up into the mountains looked down over the valley of the Armenia plain, and when the crops were ripe, they swoope down upon them. What exasperated him was t read leading articles in the papers talking of thes people as if they were all ladies and gentlemen out o Bond-street, but they were not; they were down right savages, like the people in South Africa. Th Koran had given them a certain amount of mora training, and they adhered to it according to thei lights. The Armenians were Christians, but the were a very odd lot of Christians—like the Greek —and to try and make out that the Armenia Church was a branch of the Church of Englan vas too funny. He belonged to the old Latin Church imself, but the two Churches, and the wonderful ites and ceremonies of the two churches, were idenical. When an Armenian became Roman Catholic, ll he had to do was to acknowledge the supremacy f the Pope, and declare that he abandoned what was alled the mono-physite heresy. That was the point n which they split in the 5th century relative to the ual nature of Christ. In the Roman Catholic Armeian church mass was said in the Armenian language, nd the images and relics were the same. Thereore, when they were palmed off by certain people in is country as a sort of Nonconformist, with a kind f evangelical creed, it was an entire deception. he truth had not been told; and whenever the truth as not told there was always danger.

The CHAIRMAN then proposed a vote of thanks to r. Davey for his admirable and instructive paper, hich was carried unanimously.

HIRTEENTH ORDINARY MEETING.

Wednesday, March 4, 1896; Prof. JAMES EWAR, LL.D., F.R.S., in the chair.

The following candidate was proposed for ection as member of the Society:—

ton, Prescott, City and Suburban G.M. Co., P.O. Box 1026, Johannesburg, South Africa.

The following candidates were balloted for, d duly elected members of the Society:—

Albuquerque, John Predozod, Government Laboratory, Barbados, W.I.

ydon, William, 113, Loughborough-park, Brixton, .W.

sken, Josiah R., Department of Mines, Georgeown, Demerara, B.G.

odthorpe, Colonel Robert Gosset, R.E., C.B., unior United Service Club, S.W.

The paper read was—

NTGEN'S PHOTOGRAPHY OF THE INVISIBLE.

A. A. C. SWINTON, A M.I.C.E., M.I.E.E.

uring the past month everyone has heard the photographic discovery of Professor ntgen, of Würzburg. The word photophy signifies drawing by the aid of light, while all are familiar with ordinary photraphy, in which common daylight or artil light is employed, it is because Proor Röntgen has not used ordinary light, because the results he has obtained have, ome respects, been very extraordinary, that his discovery has caused such a considerable sensation throughout the world.

In this connection it is interesting to ascertain exactly what we mean by the word light. Every tyro in science is acquainted with the classic experiment of Newton, in which the white light proceeding from the sun, or from an electric lantern, is split up by means of a prism into the familiar colours of the spectrum.

However, the spectrum that is visible to the human eye does not by any means comprise the whole of the radiations that proceed from such a source of light as the sun or the electric arc. At one end of the spectrum, beyond the dark-red portion, there are rays of radiant heat which do not affect the optic nerve, but which can be felt by other nerves of our bodies, and the existence of which is easily made apparent by means of a delicate thermometer. At the other end of the spectrum—at the end of greater refrangibility, as it is called—beyond the extreme violet, there are dark waves called the ultra violet rays, which, though invisible in themselves, have strong chemical effect upon sensitive photographic films, and can be made actually visible to the eye by means of the fluorescence that they excite in certain substances. For instance, if the spectrum is thrown upon a piece of paper which has been painted with a solution of sulphate of quinine, the violet end is greatly prolonged, and it is thus possible to see much that previously was totally invisible. As is well known, light consists of vibrations of the ether that fills all space. There can be slow vibrations of large wave length, as it is called, and there can be rapid vibrations of infinitesimal dimensions. Some of the long waves experimentally demonstrated by Hertz and Oliver Lodge, which in accordance with Maxwell's electro-magnetic theory, are identical in every particular, except size and frequency, with those with which we see, may be miles in length, and vibrate but a few hundreds of times per second. At the other end of the scale, the length of waves of ultra violet light can only be measured in millionths of an inch, and their rate of vibrations in billions per second.

The fact is that, without special appliances, the human optic nerve takes cognisance of but a very minute portion of the radiations that proceed from any luminous body; and though the word light in popular phraseology is restricted only to such radiations as affect our eyes, in a more scientific sense it includes much more.

The photography of the invisible presents no novelty. For years astronomers have employed the photographic plate for the purpose by means of the cumulative effect of long exposure of recording the existence of stars, which, owing to their enormous distance from the earth, are quite invisible to the eye, even through the most powerful telescope. It is also years since Captain Abney succeeded in the very delicate experiment of photographing a kettle of boiling water in a perfectly dark room, by means of infra red heat radiations that proceeded from the kettle itself. Again, photographs of both invisible ends of the spectrum have been common enough in connection with researches in spectrum analysis.

The radiations employed by Professor Röntgen in his photography appear, however, to differ considerably from any in the spectra of luminous bodies, as also from those produced by Hertz. Indeed, at present it is uncertain whether the Röntgen rays are of the nature of light at all. They have the pecularity that unlike light, they appear to be incapable of refraction by a prism or lens, or of anything but very imperfect reflection. Their not being amenable to refraction, at any rate to an appreciable extent, may be explained on the supposition that they consisted of very long waves similar to those of radiant heat, but against this theory we have the fact that they act upon photographic films far more strongly than do the latter, and also that even a delicate thermopile gives no evidence of their producing a rise in temperature. It seems more probable that they more nearly resemble the ultra violet rays, though here the absence of refraction can only be explained on the supposition that their wave length is so exceedingly short as to be comparable to the size of the ultimate atoms. It has been suggested that whereas ordinary light consists of what are known as transverse waves of the ether, waves similar to those existing in the sea, in which a particle of water moves vertically up and down at right angles to the direction in which the wave is travelling, the Röntgen rays consist of longitudinal ether waves more closely resembling the waves of sound in which a particle of air vibrates backwards and forwards in the same direction that the sound is moving. Or again it is conceivable that the Röntgen rays have no resemblance to light, sound, or other wave motion at all, and that they are more nearly akin to the original and abandoned corpuscular theory of Newton, and consist of particles either of very attenuated matter or of the ether itself moving in rectiliniar streams at enormou velocities.

When electric sparks are caused to pas between terminals enclosed in a glass bulb and the air is gradually removed from the bul by means of a suitable pump, a series of phe nomena present themselves to view. First all, as I will now show you, as the exhaustio proceeds, the spark which, to begin with, wa thin, broadens out into a description of flame next the flame disappears, and the who bulb becomes filled with pale phosphoresce light, the colour of which is dependent up the nature of the residual gas. Bulbs ex hausted to this degree, and containing differe kinds of residual gases, are known as Geissl tubes, and in them the luminescence under th electric discharge is believed to be due violent commotion and frequent collisio among the molecules of the residual ga which, owing to the exhaustion, are mu further apart, and are, therefore, much mo free to move about than they are in the case gases at ordinary atmospheric pressure.

If the exhaustion be continued considerab beyond the point to which Geissler tubes a exhausted, there is again a change in the ph nomena. As will be seen in the tubes that am now connecting, the small amount of that still remains in the tubes is practica non-luminous, but the glass itself is now lu nescent, more especially at a point which directly opposite the plate terminal inside t tube that is connected with the source of neg tive electricity. Further, I will show you tu in which certain phosphorescent substanc —such as the sulphides of calcium and str tium—are placed inside the tube opposite t negative terminal or cathode, as it is calle and you will see that, under the influence the discharge, these substances luminesce w great brilliancy, and with different colou according to their material.

These tubes are Crookes' tubes, and it to the labours and great experimental skil Professor Crookes that we owe much of knowledge that we have as to these phenome

As I mentioned to you, in order to prod luminescence in the phosphorescent substa placed inside the tubes, it is necessary t this should be directly opposite the cath terminal, and the luminescence is, as a ma of fact, due to some form of emanation t proceeds in straight lines from the cath terminal normally from its surface. That thi the case can be seen from the behaviour of Crookes tube that I will now put into operat

In this tube there is a screen of aluminium, in the form of a cross, which can be so placed as to be in the direct line between the cathode terminal and the glass. As you will observe when I turn on the electric current, the cross casts an intense shadow on that portion of the glass that it screens from the cathode rays. This tube also serves to show another phenomenon peculiar to these tubes. I will now remove the aluminium cross, and allow the rays to strike upon the whole surface of the glass: where previously there was a dark shadow of the cross, you now see a bright image of the same form. The explanation is this. After the glass has luminesced for a certain time under the action of the rays, it becomes fatigued, and until it has had a rest will not light up so brilliantly as before. That portion of the glass which, in the first experiment, was protected by the cross, is less fatigued than the remainder, which has been luminescing for a longer time; consequently it is now more brilliantly luminescent than the more fatigued portion.

The cathode rays are also capable of doing ctual mechanical work. I have here one f Professor Crookes's tubes, which contains a mall mill with inclined mica vanes similar to hose used in Crookes's radiometer. The athode waves, as you see, cause these vanes to otate rapidly, making them at the same time minesce with beautiful colours, due to the re earths with which they are coated.

What the cathode rays really are is a matter f some doubt. The fact that they can be deected by a magnet, as I will show you, seems support the theory held by Crookes himself, nd by most English scientists, that they con- st of streams of electrified particles of matter, robably particles of the residual gas, which eing negatively electrified are violently reelled from the negative electrode, and being this way projected across the interior of the be, produce luminescence of the glass or her substances by their bombardment. It ay be perhaps thought that the exhaustion in bes of this description is so high that there nnot be a sufficient number of molecules of sidual gas left to countenance such an exanation. According however to a calcula- n of Professor Lodge, and assuming the be that I hold in my hand has ten inches bical content, and further assuming the haustion of this tube is so good that only e hundred-millionth of the original atmo- heric pressure remains, which I may say rresponds to about one 500th of an inch in a rometric columm three miles high, assuming all this there are still some sixteen thousand billion molecules of residual air left in the tube.

However, just as in medicine, it is at present the fashion to attribute all diseases to microbes, so especially among continental scientists it is now very fashionable to attribute most things to wave motions in the ether, consequently there are many eminent scientific men, both here and more especially abroad, who do not uphold the Crookes theory of radiant matter, but who imagine that the cathode rays are more nearly akin to light or sound.

So far we have been dealing with what takes place inside the tube, and till a few years ago it was not known that apart from the light that emanated from the tube and was visible to the eye, that there was anything further. Some three years since, however, Lenard discovered the interesting fact that it was possible to bring the cathode rays outside of the tube by inserting in the latter an aluminium window. He had noticed that glass was exceedingly opaque to these radiations, and he argued that it was due to this that the radiations were not able to find an exit into the external vicinity of the tube. Lenard not only anticipated Professor Röntgen in this respect, but he also succeeded in obtaining actual photographic impressions through various substances by means of the cathode rays. He noticed that some of these rays, after they had left the tubes, were deflected by a magnet, and that others were not, that they appeared to pass without difficulty through many substances which, to ordinary light, were entirely opaque; in fact, he did some three years ago a large number of things which recently have been accepted by the public as entirely novel.

Röntgen, on the other hand, deserves the undoubted credit of having discovered what is certainly the most remarkable, and probably at present, the most useful purpose to which photography, by means of these radiations, can be put. He found that, owing to the fact that bones are more opaque to these radiations than flesh, that it is possible by their means to obtain accurate pictures of the bones in the living body. It must be understood that these pictures—some of which taken by myself I will shortly throw upon the screen—are obtained without the use of any camera or lens. They are, in fact, merely shadow pictures. They differ, however, from the ordinary shadows that would be cast by the hand or other portion of the body being interposed between a source of light and a screen, in that with the Röntgen rays the bones cast a more dense shadow than the flesh, and are, consequently, visible through the latter on the developed photograph. Similarly metallic objects enclosed in a wooden box, or coins in a purse, cast more intense shadows than the wood of the box or the leather of the purse, and thus impress their images upon the photographic plate.

Further, it must be understood that Röntgen, in his experiments, employed no aluminium window to his tube, and it is a question whether his rays are really at all of the same nature as Lenard's cathode rays. It may be that the cathode rays, on passing through the glass walls of the tube, become converted into something else, or that a portion of them—that portion that is deflectable by a magnet—are as it were filtered out. In any case, the Röntgen rays have many peculiarities. They penetrate with little difficulty many substances which, to ordinary light, are quite opaque. They penetrate metals with difficulty, though all metals in sufficiently thin sheets appear to be more or less transparent to them. The heavier metals are most opaque, and aluminium, which is one of the lightest of metals, is one of the most transparent. They pierce most organic materials with ease, and, apparently, without much regard to their colour. For instance, ebony does not appear, in any appreciable extent, to be more opaque than pine. Ebonite, vulcanized fibre, black paper, and other substances which are entirely opaque to ordinary light, are exceedingly transparent to these rays, while glass, fluorspar, and other substances that are very transparent to light, to these rays are remarkably opaque. In fact, the opaqueness or transparency of substances to ordinary light is no guide whatever of their transparency to the Röntgen rays, and as has recently been discovered by Professor Dewar, the true fact of the case seems to be that the transparency of substances to these rays is inversely proportional to the atomic weights of their elementary constituents. This connection with gravity is most interesting, for while on the one hand it supports the theory that these rays are not similar to light, but more resemble streams of minute projectiles which are more or less arrested in their course by the inertia of the particles of the target against which they are thrown—on the other hand it has long ago been suggested that gravitation may be due to a longitudinal wave motion of the ether.

Another peculiar affect of these rays has been investigated by Professor J. J. Thomson, nd consists in the facility with which they
discharge an insulated body charged wit
either positive or negative electricity. In fact
any substance, however good an insulator i
may be, under ordinary circumstances seem
to become a conductor of electricity during th
time that the Röntgen rays are passin
through it.

This can be shown experimentally by mean
of a gold leaf electroscope such as I have here
This electroscope indicates the presence of a
electric charge in the metallic disc on th
upper part of the instrument by the divergenc
of the two gold leaves, which when electrifie
similarly, repel one another. As you wi
observe when I charge the disc by means of
piece of rubbed glass or sealing wax in th
ordinary manner, the disc holds its charg
fairly well. I will now allow the Röntgen ra
from a Crookes tube to fall upon the di
through an aluminium window cut in this le
screen. As you will see the leaves immediate
fall together, showing that the electric charg
rapidly leaks away. As you will see, wheth
the disc be electrified negatively or positive
the result is the same. If, however, I clo
the window in the lead screen by means of
sheet of lead, you will now observe that t
leakage is very must less rapid. The expe
ment in fact demonstrates the fact that le
is much more opaque to the Röntgen rays th
is aluminium. Consequently this method c
be applied even better than can photograp
to the exact determination of the opacity
various substances to these rays. It can al
be used for the purpose of noting the intensi
of rays that are generated by any particu
Crookes tube.

The best form of Crookes's tube to employ
practical photography of the invisible, or rat
hidden, depends considerably upon the descr
tion of electric current that is available. Wh
continuous or direct current obtained eit
from primary batteries, storage cells, or fr
the street mains can be used, and this curr
which primarily is of comparatively low volta
is transformed up to the necessary high volt
by means of an ordinary Ruhmkorff coil w
its contact breaker, tubes of the form show
the diagram on the wall will be found to g
excellent results. In this description of t
the cathode consists of a plate of alumini
and it will be found that the Röntgen r
proceed from the tube from a patch on the g
which is more vividly phosphorescent than
rest, which is immediately opposite the cath
plate. Where the anode is placed it does
seem to greatly signify.

This is the form of tube, I believe, employed y Professor Röntgen himself; but during the ast few days Messrs. Newton have placed on he market in London a new form of tube, hich certainly gives very superior results. It as, I understand, designed at King's College. n it the cathode plate is made concave, so as focus the cathode rays upon a point on a iece of platinum foil, which forms the anode. he platinum foil is bent at an angle of 45 egrees to the direction of the cathode rays, as to throw down the Röntgen rays, which this tube proceed from the platinum and not om the glass. This tube has two great dvantages: firstly, as the Röntgen rays roceed practically from a point, it gives a arpness of definition otherwise unattainable; rther, since the cathode rays are directed on e platinum and not on to the glass, there is uch less chance of the tube being destroyed heating and cracking of the glass, and for is reason it is possible to excite the tube to a uch higher extent, and consequently to work th shorter exposures than is practicable with y other tubes with which I am acquainted. fact, from the point of view of the practical plications of Röntgen's photography, it pears to me that this tube represents the st important advance yet made in connec- n with the required apparatus.

When, however, direct currents are not ailable, and alternating currents must be ed, an entirely different arrangement appears sirable. In this case, since each terminal the tube is alternatively positive and nega- e, it is necessary that each must be capable performing the functions of cathode. It is o necessary that the radiations should pro- d from a single part of the glass, or other- e the resulting photograph may be compli- ed by the production of double shadows. th alternating current, the form of tube wn in Fig. 2, on the wall, in which terminal is a circular plate, and the er a concentric ring of aluminium, will found suitable, and for the purpose of iting such a tube the so-called high uency arrangement of Tesla will be found y efficient. In this arrangement the rnating current having been transformed to say something like 20,000 volts, is ployed to charge Leyden jars, which can charge themselves across a spark gap, and also connected to the primary of a second immersed in oil, to the secondary circuit hich the terminals of the tube are attached. precise arrangement of the connections is best seen by means of a diagram, which I will show in the lantern. So much for the form of the tube, but there are other points of the highest importance in connection with its manufacture. First of all it is necessary that the tube itself be constructed of what is known as German glass, that is to say, glass in which soda is employed, and not lead, as is used in English glass. Further, the tube must be exhausted to an extremely high extent. What is exactly the best exhaustion is a matter of some uncertainty. The exhaustion can be too high, in which case it will not light up properly, but in most of the tubes with which I have had myself to deal, it has been more often too low. In order to get really the best results, with the shortest exposures, probably the best arrangement is to keep the tube connected all the time to a mercury pump, so that the amount of exhaustion can be increased or decreased to the exact extent that experiment shows to be advisable. This arrangement is perhaps the more necessary for the reason that though tubes may, when new, be exactly in the very best condition as regards exhaustion, it is unlikely that they will remain for long in this condition. In some cases the vacuum will become higher, and in some cases it will become lower with use. In the former case this is probably due either to absorption of the residual gas by the electrodes, or by condensation of the gas upon the glass, and in the latter case to some gas absorbed or occluded by the electrodes or condensed upon the glass being driven off by the heating that accompanies the passage of the electric discharge.

I will now show you a Tesla coil of the description mentioned, but of considerably larger size than is necessary for merely exciting Crookes tubes in operation. As will be observed the nature of the electric discharge of such a coil differs very considerably from that produced by an ordinary Ruhmkorff coil, and, as you see, it will brilliantly light up Crookes tubes connected to only one terminal, or even tubes with no terminals or connections at all, that are merely held in its vicinity.

There can be no question that the Tesla coil arrangement is very efficient for the purpose of producing the Röntgen rays from a Crookes tube. It is, however, exceedingly destructive to the tubes themselves, and though I am inclined to believe that with specially-constructed tubes, capable of resisting its action, a greater intensity of Röntgen rays are produced than with the ordinary Ruhmkorff coil, still with such tubes as can at present be obtained the latter is probably the more practical arrangement.

I now propose to actually take some photographs by the Röntgen method, and the results will be developed, and, if successful, will be shown to you in the lantern. We have here six photographic plates, of the commercial gelatino-bromide description. Each plate is enveloped in a double envelope of black paper, to protect it from ordinary light. We will place these photographic plates on the table, and upon them various objects, such as a purse containing coins, a pair of spectacles in their case, a pencil, &c. Above the objects, at a vertical distance of some eight or nine inches, we suspend the Crookes tube. We will give an exposure of forty-five seconds.

We are using here, and I have always used ordinary photographic plates coated with gelatino-bromide of silver. I do not think, however, that it at all necessarily follows that ordinary photographic plates which are made so as to be most sensitive to ordinary light, are the best for Röntgen photography. In any case it appears to me probable that the sensitiveness of photographic plates to these rays might very probably be largely increased by treating them with fluorescing substances, or even by arranging a fluorescent screen to be in contact with the film during the exposure.

At the beginning of this paper I mentioned how it was possible to render visible to the eye the invisible ultra violet rays of the spectrum. It is interesting that, by a similar method, it is possible to render visible the Röntgen rays, and thereby actually to see the shadows cast by those rays of hidden objects, and even of the bones within the living body. Lenard was the first, I believe, to discover that it was possible to produce luminescence in phosphorescent substances outside a Crookes tube. Röntgen investigated the subject further, and states in his paper that, by means of a fluorescent screen, formed of paper impregnated with platino-cyanide of barium, it was possible to make visible to the eye the shadows cast by the bones in a human hand.

More recently, Prof. Salvioni, of Perugia, has described an instrument which takes advantage of this phenomenon, and which consists of a cardboard tube, at one end of which is an aperture to which the eye is applied, the other end being furnished with a screen made opaque to ordinary light, and coated on its inner side with phosphorescent material. I have such an instrument here, and by its means I have been able to see distinctly the shadows not only of coins in purses, of metallic objects in wooden boxes, and through aluminium plates, but even with considerable distinctness the bones in the thicker portion of my own hand. The method of using the instrument is very simple. The eye is applied at one end of the tube and fixed upon the fluorescent screen in the interior, while against the back of the latter is placed the purse, hand, or other objec to be observed. On the other side of this objec is the Crookes tube, so that the rays cast the shadows of the objects upon the screen. Thi fluoresces more or less according as the ray are free to pass or are intercepted with th result that a visible image is formed upon th screen. This instrument at present is ver imperfect, but it seems capable of considerabl improvement. For surgical and medical pur poses it would indeed be an advantage if th bones and interior organs of the body could b inspected without the necessity of tediou photographic processes. Even in its presen shape however the instrument is useful, for th reason that by its means it is possible at onc to determine whether a tube is working sati factorily, whether it is giving a sufficient i tensity of rays, and whether the shadows ca by it are sharp. It will also show that the glas when fatigued, does not transmit the Röntg rays.

Professor Röntgen's discovery is undoubted one of very considerable importance. It h excited the popular imagination in a mann unknown since the days of the telephone a microphone. Already, though it is but a f weeks old, the discovery is bearing fruit, that it is being daily applied in practi surgery, more especially for the purpose locating needles, bullets, and other extraneo s objects which have become embedded in flesh. On its further improvement it c scarcely fail to become still more valuable, s there seems every prospect by its means f being able to determine the extent of c careous deposits in the interior organs of e body, malformations and diseases of the bo, &c. It may, in time, be possible to ph graph, or even, and this would be still m e useful, to actually see the interior organs n operation, and it is scarcely necessary to p t out the extreme advantage that this w d have, not only for the purpose of determin g and curing the ills to which flesh is h r, but also in investigating and understand g many of the obscure processes which ke place within the body.

Further, as we have seen, the disco ry

of extreme interest from a point of ew of physical science, giving as it does esh insight to many matters of the highest ientific importance. It is not many years nce Lord Kelvin stated that the discoveries Hertz had annexed the whole science of tics to the domain of electricity, and the bours of Röntgen and Lenard have advanced yet another step towards a knowledge of e real nature of both luminous and elec- cal activities. It is by slow degrees that e mists which obscure the panorama of the iverse are dissipated, but the prospect surely dens year by year.

DISCUSSION.

Mr. **Brooks** said, in March, 1877, he made a nmunication in that room to the South London otographic Society with regard to non-luminous inic rays, but he had no electric appliances, and d a horse-shoe magnet. By exposing plates in nplete darkness to the action of the magnetic field obtained certain images, and found that even out- : that there were invisible rays by which he could tograph through blackened cards, as had been wn that evening. But when he brought this subject vard, it was pooh-poohed, and so he let it drop, He uld now renew his experiments, especially as he seen some things now which explained what he ld not then understand. He found that the rays ised were not due to magnetism, although associ- l with it; and he also found he could even get rays 1 the fingers. In those days wet plates were ersal, and a friend of his asked him for some nicals and a bath to prepare some plates; he : them to him, but next day his friend said were useless, for every plate fogged. He self then excited a plate, and exposed it, and d it perfectly clear, and so he came to the con- on that there was some effect due to his friend's onality, and he proved this to be the case; for lacing of his friend's hand on the back of a plate enough to fog it. In those days there were no matic holders, and each plate had to be held by orner, and on investigating the matter he found in about two or three per cent. of cases, rays given off from the tips of the fingers which shoot wo or three inches.

ie **Chairman** proposed a cordial vote of thanks r. Swinton for the interesting and almost epoch- ng paper he had read. He had done a real ce to science in bringing before the general c the remarkable results that Professor Röntgen btained so shortly after their discovery. The the public were interested in scientific matters genuine kind, the more secure would be the future of England. There might be material isolation, but there was no possibility in the future of intellectual isolation. Consequently, a scientific discovery of such great importance as this, which had awakened public interest in every country in the world, was something to be really thankful for. It was stimulating to the cultivation of real science to have a brilliant discovery like this (probably the most remarkable which had been made within the last half century; seeing that it had been rendered practically useful within less than three months of its publication), generally appreciated. They could see no end to the future work in abstract science which it opened up. It had, at the same time, stimulated a kind of criticism to which, perhaps, Mr. Swinton would be exposed, but which, in his opinion, ought not to be entertained. That was the view that a scientific discoverer had some kind of monopoly for an indefinite period of time in his discoevry, and that his position was similar to that of an inventor. He should not have been surprised if this view, which had recently been promulgated in the scientific journals, had led to a kind of injunction being asked against their friend. He could not understand that position. There was no monopoly in science, and he felt convinced, though he had not the honour of knowing Professor Röntgen himself, that he would not regard this widespread interest in his work as in any way detracting from his merits, but rather as adding new laurels to the value of the original investigation. He was sure Mr. Swinton would be the last man to do anything else than exhibit the marvellous fertility of Röntgen's discovery. To say that any investigator, if he locked the door of his laboratory and cultivated his own garden—as had been suggested—for a permissable period, could have done as much in three months as had been done in this case through publicity, would be simple nonsense. He could not but think that such ideas rather suggested that, instead of having regard to the real objects of science, there was too much consideration being given to the personality of the investigator. Now the merits of the investigator had often very little to do with the importance of the discovery. That was one reason why there could be no such thing as monopoly. Look at the antecedent work involved in Professor Röntgen's discovery. On the one side you had the heredity from Faraday, who first suggested lines of force, to the great development made by Maxwell, to the work of Varley, and to that of Crookes. On the other hand, you had the work of Herz, Lenard, and the work of Professor Röntgen. There were three Germans who had cultivated this field, and at least four Englishmen who had done admirable work. We, therefore, had our own share in the development of Röntgen's discovery, and every step had been necessary to the ultimate achievement. Of course they always felt that somebody else might have discovered something, and that it was a pity he missed it; but really one man could not expect to monopolise everything, and there was plenty yet to be found out. You had only to go over the most elaborate investigation of the most brilliant man before you, and you would be sure to find something he had not seen; something the world ought to know. As regards the theory of the X rays, he noticed that Mr. Swinton was much in the position of other investigators—he declined to commit himself. He had put several suggestions before them, and they must select the one which seemed to them most suitable. Probably Professor Röntgen was well advised in calling them the X rays. The problem still awaited solution, but probably within a year they would know more about it. If not, it certainly would not be for want of minds all over the world best able to deal with these obstruse problems being concentrated upon it. They could not but feel that they were on the dawn of new knowledge with regard to the most recondite and most interesting of all kinds of substance, viz., the material medium called ether. That was really, they believed, what they were now touching, and that after all was the most widespread medium or material in the universe, connecting world to world, the stellar system and the nebulæ to our earth, and yet, at the same time the means of communication between atom and atom. This discovery seemed to open out a new mode of attaching the ether, and to show a new and striking use to which this medium can be put. First light, then electricity, and now a new kind of radiation, which it would take years of labour to investigate, had been in succession added to the functions of the ether. But, at any rate, the brilliancy of this discovery would remain, and their thanks were due to Mr. Swinton for the admirable way in which he had brought it before them.

The vote of thanks having been carried unanimously,

Mr. **Swinton**, in acknowledging it, said it had been a great pleasure to him to show the results, and the success which had attended the experiments was in large measure due to the assistance of Mr. Stanton, who had been working with him, and to the facilities afforded him by the Society of Arts.

Correspondence.

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THE REPORT OF THE ROYAL COMMISSION ON SECONDARY EDUCATION.

I note without surprise that the Rev. J. O. Bevan is annoyed at my exposure of the private schools' position and Association. I do not, however, observe that he meets my point that his Association representing (a fractional part of) private elementary schools masquerades as a body concerned with secondary education. I am not aware that he gives me notice when at his own association meetings at similar so-called teachers' functions, he mak statements without foundation as regards publ authorities. I specially invited to my lecture D Wormell, and was informed also that Mr. Thornt would very likely be there also; I thus took necessary precaution to secure the presence of perso competent to answer me. I do not intend to co ment upon Mr. Bevan's quotation of some of flowers of speech; I can assure him, however, tha have plenty more of the same sort in store for hi My remark about the Oxford Conference has its support the high authority of the Bishop Southwell, and I could give equally good author for the others. Now as to my illogical statemen Mr. Bevan has apparently not even taken the trou to read them. I said *theoretically* private pr schools have no business to exist, but as the res of a "*practical* consideration of the position these schools" (page 363) I showed how effect of the Report would be to strengthen those that are *efficient*. Mr. Bevan, appare does not know the difference between theory practice; or perhaps he is pleading for the " efficient" schools. I need scarcely say I enti agree with his quotations from the Report, and I showed a more excellent way of "keeping th schools in the field," stimulating and improv them, and at the same time preventing them f sailing under false colours. But it is a curious of gratitude for this Report upon the part of Bevan and his associates for them to abuse the fi ings of the Commissioners, and flood the cou with leaflets about "secularisation," &c., w (I quote from one) can be obtained *without the* "issued by the Private Schools Association."

As to my other "inconsistency," I said that power of *compulsory rating by means of precept* not pass into law; I did not say that I do not a with it, nor that I am not prepared to support whole Report, even including this provision; in the place where this provision will be rejected wi the House of Commons. It is untrue to say th said it ought not to pass into law; the words w I particularly avoided are inserted by Mr. Bevan.

I am glad he admits that the Report aim giving private schools an "assured position;' will have my support in seeing that this positio an *assured* and not a *pretended* one. But the step he will have to take is to purge his Associa from persons who desire to deprive parents of money and children of their opportunities, Matthew Arnold has it. He has already expurg the *list* of his members, so that a gentleman app there as Mr. A. B., while in the prospectus issue parents he is gorgeously arrayed as "Mr. A. F.G.S., F.S.Sc., first-class honours and med (London), able to teach 16 subjects, under Government Department of Science and A perhaps Mr. Bevan will go further and purify membership itself. Then perhaps, but not be

: may be included among the "friends of educa- on," a goodly number of whom were present at my cture, and as *cultores veritatis fraudis inimici* were neither insulted nor wounded."

H. MACAN.

Kingston-on-Thames, Feb. 29th.

P.S.—I shall be happy to discuss these matters ith Mr. Bevan upon any platform and anywhere.

Notes on Books.

TROLEUM: a Treatise on the Geographical Distribution and Geological Occurrence of Petroleum and Natural Gas, the Physical and Chemical Properties, Production and Refining of Petroleum and Ozokerite, the Characters and Uses, Testing, Transport, and Storage of Petroleum Products, and the Legislative Enactments relating thereto. By Boverton Redwood, assisted by George T. Holloway and other contributors. London: Charles Griffin and Co, 1896. 2 vols. 8vo.

The subject treated of in these fully-illustrated lumes is so vast, that it is not surprising to learn at even with 900 closely-printed pages at his dissal the author has found it difficult to get all his terials within that space. The work is divided o eleven sections, and a short notice of the conts of each of these will give some idea of the alth of material which is placed at the service of : reader. Section 1 contains a general historical count of the petroleum industry. Although the owledge of petroleum is of great antiquity, the tory of the early period does not occupy much ice, and the reader is at once taken to the two at sources of the modern supply—the United ates and the Baku district. Section 2 deals with : geological and geographical distribution of petrom and natural gas, and here various theories of gin are considered. This section is fully illusted by maps and plans of the various oil-fields. ction 3 is devoted to the consideration of the mical and physical properties, and Section 4 to : origin of petroleum and natural gas. "The ories which ascribe an inorganic origin to petrom are considered inadmissible by most geologists l others acquainted with the conditions under ich the many widely different descriptions of the duct are met with," and, therefore, the vegetable l animal origin is largely accepted. Section 5 ls with the modes of productions in different tricts, and Section 6 with refining. Section 7 is oted to a description of the shale oil and allied ustries which first came into existence in 1847. e questions of transport, storage, and distribution petroleum are discussed in Section 8, and here is en a full account of tank steamers. Section 9 tains an account of the testing of crude petroleum and shale oil products, ozokerite, and asphalt. Section 10, on the uses, contains notices of mineral oil lamps, spray lamps, mineral spirit lamps, and lamps for solid paraffin; air gas and carburetters, and oil gas; petroleum as fuel, petroleum-engines. Section 11 deals with statutory, municipal, and other regulations relating to the testing, storage, transport, and use of petroleum and its products. Three appendixes (*a*, statistics; *b*, particulars of marine transport; *c*, import duties levied on petroleum) complete the work. It will be seen from this short abstract of the contents of the book how large is the field that Mr. Boverton Redwood has traversed, and that the record of his researches forms a sort of encyclopædia of the subject.

THE BOOK-PLATE ANNUAL AND ARMORIAL YEAR-BOOK. 1896. Edited by John Leighton. London: A. and C. Black. 4to.

This is the third annual issue of a publication devoted to the modern craze for book-plate collection. It contains articles on the book-plates of the Royal Society and the Society of Antiquarians, on the dispension of the treasures collected by Horace Walpole at Strawberry-hill, a review of Miss Labouchere's work on the Ex-Libais of ladies, and some suggested book-plates in honour of Burns and Carlyle. The pamphlet is fully illustrated.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 11.—"Peasant Life and Industries in Ireland." By PROF. A. C. HADDON. THE DUKE OF ABERCORN, K.G., will preside.

MARCH 18.—"Bahamas Sisal Industry." By DR. D. MORRIS, C.M.G., M.A. GENERAL SIR HENRY W. NORMAN, G.C.B., G.C.M.G., will preside.

MARCH 25.—"Our Food Supply, as affected by the Farming of the Future." By PROF. JAMES LONG.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E. The EARL OF DUNMORE will preside.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of April 23, and May 14 will be held at the Society of Arts; those of March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

MARCH 10.—"English Book Illustration, 1860-70." By JOSEPH PENNELL. LEWIS F. DAY will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

The meeting announced for March 17th will not be held, and Mr. H. Vogel's paper on "The Maories" is unavoidably postponed.

MARCH 24.—"The Colonies and the Supply of Dairy Produce and Prodncts of Petite Culture." By CHARLES R. VALENTINE. SIR WESTBY B. PERCEVAL, K.C.M.G., will preside.

APRIL 21.—"Madagascar." By CAPTAIN PASFIELD OLIVER. MAJOR MARINDIN, C.M.G., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

H. GRAHAM HARRIS'S Cantor Lectures on "Refrigeration," announced for delivery on March 9, 16, and 24, are unavoidably postponed.

HENRY A. MIERS, M A., "Precious Stones." Two Lectures.

April 13, 20.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 9...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. G. W. Herdman, "A Hinged Form of Astygmatic Eye-Glasses." 2. Mr. G. A. Edwards, "Improvements in the Application of Telephones to Electric Bell Systems."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. H. Haywood, "A Tour through Australia."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, MARCH 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Joseph Pennell, "English Book Illustration, 1860-70."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Covering of Plants and Animals: its Structure and Functions." (Lecture IX.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., p.m. 1. Adjourned discussion on Mr. Willia Henry Wheeler's paper on "Littoral Drift i Relation to River Outfalls and Harbour Entrances." 2. Mr. J. H. Clemes, "The Lixiviation o Silver Ores." 3. Mr. C. F. Courtney, "Minin and Treatment of Copper Ore at Tharsis, Spain." 4. Messrs. John McKillop and T. Flower-Ellis "Tin Smelting at Pulo Brani, Singapore."

Photographic, 50, Great Russell-street, W.C., 8 p.m Messrs. Edmund Roughton and Charles Cosens "Notes on Medical Photo-Micrography."

Anthropological, 3, Hanover-square, W., 8½ p.m Col. R. G. Woodthorpe, "Some Account of th Shans and Hill Tribes of the States on th Mekong."

Colonial Institute, Whitehall-rooms, Whitehall place, S.W., 8 p.m. Sir G. Baden-Powell, "Development of Tropical Africa."

Cymmrodorion, 20, Hanover-square, W., 8 p.m. M Alfred Nutt, "Morgan and Arthur: a Study i Heroic Legend."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.

WEDNESDAY, MARCH 11...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Professor A. C. Haddo "Peasant Life and Industries in Ireland."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, Parkes Museum, Margaret street, W., 8 p.m. Mr. Augustus C. Scovel "The Isolation of Cases of Infectious Disease i the Metropolis."

Japan Society, 20, Hanover-square, W., 8½ p. Dr. A. V. Markoff, "The Historical Developme of the Japanese Language."

Royal Literary Fund, 7, Adelphi-terrace, W.C 3 p.m. (Annual Meeting.)

United Service Institution, Whitehall, S.W., 3 p. Prof. J. K. Laughton, "The Study of Nav History."

THURSDAY, MARCH 12...Royal, Burlington-house, W., 4½ p.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, Conduit-street, W., 8 p.m. Conversazione at t Galleries of the Institute of Painters in Wat Colours, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p.m. Re William Barry, "Masters of Modern Thought (Lecture II.—Rousseau.)

Electrical Engineers, 25, Great George-street, S.W 8 p.m. Discussion on Mr. Addenbrooke's Pape "High Voltage Lamps and their Influence Central Station Design."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8 p.m.

Civil and Mechanical Engineers, 45, Charing-cros S.W. Messrs. H. Coward and R. Booth, "Publ Baths and Washhouses."

FRIDAY, MARCH 13...Women Journalists (at the HOUSE THE SOCIETY OF ARTS), 8 p.m. Mr. T. P. O'Conn "Literary Criticism."

Royal Institution, Albemarle-street, W., 8 p. Weekly Meeting. 9 p.m. Mr. W. S. Lilly. "T Theory of the Ludicrous."

Civil Engineers, 25, Great George-street, S.W., p.m. (Students' Meeting.) Mr. J. C. Cornoc "Tests of Centrifugal Pump."

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W 5 p.m.

SATURDAY, MARCH 14...Royal Institution, Albemarle-stre W., 3 p.m. Lord Rayleigh, "Light." (Le ture IV.)

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.

Journal of the Society of Arts.

No. 2,260. Vol. XLIV.

FRIDAY, MARCH 13, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

APPLIED ART SECTION.

Tuesday, March 10, 1896; LEWIS F. DAY in the chair.

The paper read was "English Book Illustration, 1860-70." By Joseph Pennell.

The paper and report of the discussion will be printed in a future number of the *Journal.*

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1896 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 11th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to His Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus Von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., late Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to HER MAJESTY THE QUEEN.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph Lister, Bart., F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal.*

Proceedings of the Society.

INDIAN SECTION.

Thursday, Feb. 27, 1896; Lord HARRIS, G.C.S.I., G.C.I.E., in the chair.

The paper read was—

THE TOBACCO INDUSTRY OF INDIA AND THE FAR EAST.

By C. TRIPP

(Formerly of Sumatra).

The successful development of the tobacco industry on the east coast of Sumatra during the last quarter of a century, and the enormous returns to the capital and labour engaged therein, have not unnaturally led to a keen inquiry from those engaged in the same industry, but with less fortunate results, as to the set of causes and circumstances which have raised the produce of Sumatra above all other tobaccos of the East. Wherever there exists suitable soil, climate, and labour, you may be said to have secured the preliminary conditions towards the production of a high class tobacco. These conditions I shall term "special factors" to distinguish them from the conditions necessary to every agricultural industry, such as capital, seed, &c. A combination of these three factors will yield tobacco of the very first quality; subtract one factor, and you may still have tobacco, but it will be of an inferior description. It is in the Deli and Langkat districts of the east coast of Sumatra that this rare combination of these special factors exists almost in a state of absolute perfection, and it is, therefore, in these districts that the finest Sumatra leaf is produced. Each factor ranks in importance in the order in which I have stated them.

Walker & Boutall sc

First comes the soil, and if this does not contain all the constituents necessary for the production of good tobacco, not the most avourable climate in the world, nor the most skilled labour, will obtain from it other than an inferior tobacco. Sumatra itself affords a striking instance of this proposition. The district of Deli is divided from the district of Serdang by a river whose proportions scarcely exceed those of a stream Yet some of the most fertile of the Del estates extend right up to the banks of this river, while on the other side, a mere jump commence those Serdang estates, which with the same climate and with equally skilled labour never have produced, and perhaps never will produce, tobacco of the Deli quality. Neither art nor science can remedy the defect when nature fails. Fertilisers of all kinds have been tried, everything that human ingenuity could suggest has been attempted, yet the Serdang tobacco continues to be inferior to the Deli product in point of texture, colour, and combustion, and to realise considerably lower prices on the Amsterdam market. The soil of Deli and Langkat, which produces the choicest leaf, is a friable volcanic loam, and it is in quest of this desirable natural agent that search has been made throughout the mainlands and islands of the East. India, Burma, the Straits Settlements, Southern and Western Sumatra, certain islands of the Dutch Archipelago, New Guinea, Borneo, and even Africa have all been tested, and, with the exception of Borneo—to which I shall again refer—found wanting. When a soil which will produce tobacco is found, care should be taken not to work it too severely. The more favoured districts of Sumatra are second to none in richness and fertility, yet it is not deemed advisable to take more than one crop in seven years off the same soil. There are instances of crops being gathered from the same land every two or three years, but this can only be accomplished by the constant and abundant application of manure, which injuriously affects the flavour, and, furthermore, produces a plant which lacks both quality and stamina. The Sumatra planters lay great store on the re-afforestation of the land after the crop has been taken from it, deeming that the most suitable land on which the second growth of ungle is the thickest. It is only on the assumption that a crop of grain, which invariably follows a crop of tobacco, and which is compulsory by law, hinders the re-growth of he jungle, that so much opposition to this grain crop is exhibited. These fears, however, appear to be groundless, as experts agree that a grain crop, while extracting from the soil none of the constituents favourable to the growth of tobacco, restores to the soil certain conditions which are essential for the growth of that plant. Tobacco is known as the best of drought plants. Stagnant water is its greatest nemy. The greatest attention should, therefore, be paid to the thorough draining of the land. A rapid filtration of water though the roots should be assured, as allowing it to accumulate, for however short a time, means ertain destruction to the plant.

The second preliminary condition towards the tobacco cultivation is climate, the importance of which cannot be over estimated. Without the required humid, warm temperature, and the regular seasons of sunshine and rain, the most admirably adapted of soils will yield a product deficient either in quantity or quality, or both. We have the best proof of this proposition in British North Borneo, where, with a soil inferior to none, tobacco cannot be produced in paying quantities owing to the unreliability of the seasons. The rains and floods frequently deluge the country at the time the crops are standing, causing havoc and devastation, against which no human foresight can provide. We suffer in Sumatra from floods caused by the swollen rivers overflowing their banks, but, fortunately for the country, these deluges occur generally at a time of the year when the crops are gathered into the sheds, and so result in nothing more than a little temporary inconvenience.

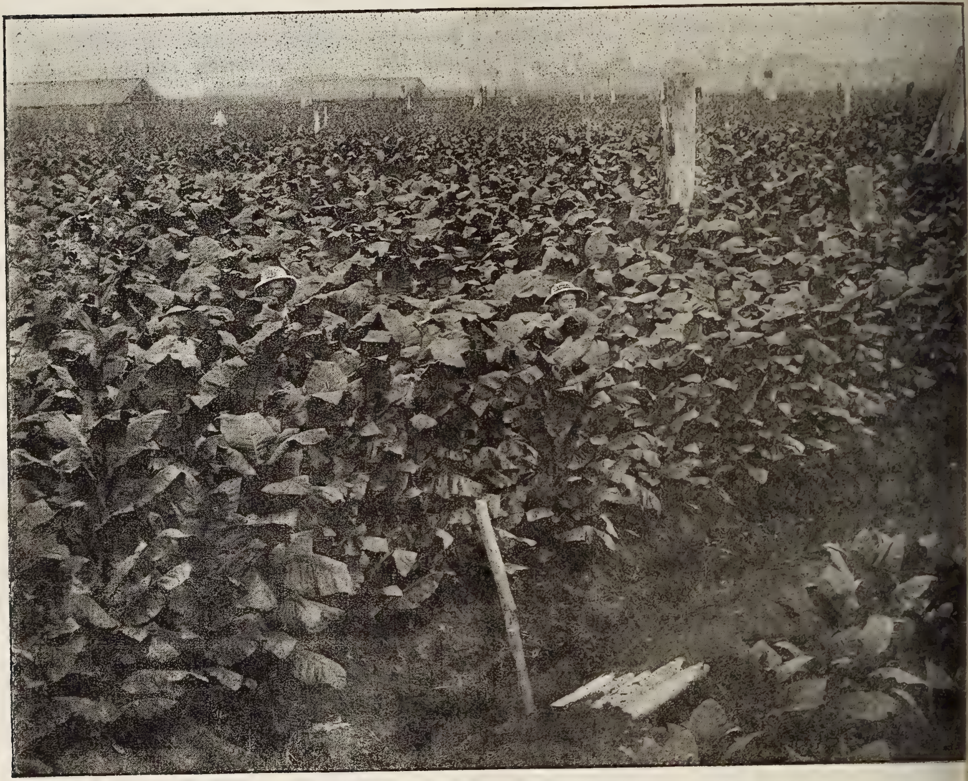
The third essential factor in tobacco cultivation is labour, and by labour I refer not so much to the mechanical work of the coolie as to the higher, more artistic, and more intelligent efforts of the European planter and his assistants and overseers, who direct and instruct the native labourers in their duties, and are absolutely responsible for the cultivation of the plant throughout all its successive stages, commencing with the hoeing of the land and the selection and sowing of the seed and concluding with those infinitely more delicate operations—the sorting, fermenting, and preparing the tobacco for the European market. "Any fool can grow tobacco" is a trite and substantially true expression, as the actual growth of the precious weed is a matter of great facility, especially when, as in Sumatra, Nature is propitious. But I assure you that as it is an easy task even for a fool to grow the weed, so is it a still easier one for him to spoil it, when he has it. There is no more delicate plant than tobacco, and consequently none that needs more constant care and vigilance, and more assiduous skill and attention. It is well within my own experience and that of every man connected with the tobacco industry of the East, that by a mere change of management, estates, hitherto unproductive and unprofitable, have proved to be fertile and lucrative to a degree. It is a notorious fact that some of the best yielding estates in Sumatra failed to repay their original owners the cost of production. They changed ownership for a mere nominal sum, the vendor thinking himself lucky to be rid of what was to him a white elephant in the shape of a Sumatra tobacco estate and willing, if the truth were known, to accept half the sum he actually received for the property; the purchaser, strong and confident in himself, rejoicing in the acquisition of a property for which he would, if the truth were known, have paid double the sum that he actually parted with. And so it is that we find most of those great Dutch 100 per cent. dividend companies, indebted to the errors and the failings and, shall I say, the follies of the pioneers of the country, for those veritable gold mines which are the source of their wealth. There is quite a touch of the irony of our existence in the contemplation on the one hand of the ease and comfort enjoyed by the happy recipients of cent. per cent. per annum dividends, and on the other hand, of the unhappy pioneers who have nothing left them of all this possible prosperity but the contemplation of lost opportunities. Though the history of the tobacco industry in Sumatra bristles with instances of how the most favourable conditions of soil and climate can be completely neutralised by unskilful or inefficient labour, I know of none which tend more vividly to illustrate my argument than the experience acquired by those English companies which have invested their capital in this industry. The United Langkat Plantations Company was formed in 1889, with a paid-up capital of £200,000. In an early period of their existence they got into trouble and lost a considerable portion of their capital. A change of management came, and from that time the company commenced and has continued to prosper. The history of the British Deli and Langkat Tobacco Company, Limited, which was also formed in 1889, with a capital of £234,000, is but a repetition of the same story. A change of management converted this company from a losing into a dividend paying company. To-day, the shares of both these companies are in keen demand as a remunerative investment.

I have purposely enlarged on these two examples, as they appear to me to afford all the evidence that can possibly be required of the importance of the labour factor in tobacco cultivation, and of the absolute necessity, if the cultivation is to be brought to a high state of perfection, of the planting and curing operations being under the superintendence of men of ability and experience. In one respect labour may be considered as the most important factor in the industry under discussion, a being a removable factor, it can be so altere and improved upon as to be brought as ne to perfection as anything can be. Soil an climate, on the other hand, are stationary an permanent factors, which can be but slight changed even by the aid of science.

A good tobacco planter requires not to be man of brilliant parts or high intelligence, ar perhaps that is a reflection from which u successful planters may derive comfort ar consolation. On the contrary, those gif of intellect which are needful to a brillia statesman, or journalist, or a successful ma of business, would in all probability be stumbling-block in the career of a tobacc planter. A tobacco planter, unlike a poe is made—not born. Sound common sens the power to observe and draw accura conclusions, a knowledge of mankind, tl ability to govern all sorts and conditions men, and at the same time to retain the respe and esteem of those you govern, the gift organisation, the moral strength to enfor discipline: such are the attributes of tl successful planter. Monotony, exile, so tude, the absence of any necessity for gre mental exertion, the concentration of one thoughts and faculties on one object, a that nothing more than a tobacco plar the constant and enforced intercourse wi men of like singleness of ideas, to all the disadvantages the planter must submit, a he rarely emerges from the ordeal before h mental faculties, from long desuetude, ha fallen into a state of torpidity and stagnatio To men of active intellects such a conditi must be intolerable, and it is, therefore, th common sense, practicalness, and a sou constitution are more likely to produce su cessful planters than those more ordina attainments—great learning and intelligence

Hitherto I have dealt only with the skill labour of the European, the importance which I have proved to demonstration, but t less important, but none the less highly nece sary manual and mechanical labour of t native coolie must not be lost sight of. Sumatra, at the present day, none but Chine labour is employed on the actual process cultivation, though assistance is rendered the natives of Java and the Madras Presiden in the construction of roads, ditches, a buildings. Javanese labour is cheaper a more plentiful than Chinese, and with a vi to economy, efforts have been made to produ tobacco with Javanese labour only. The experiments proved to be costly ones, as they resulted invariably either in total failure, or else in a small yield of inferior growth. To-day, none but Chinese labour is employed, and it is generally acknowledged that this labour is more fit than any other for the work required. The natives of Java and British India lack the muscular vigour and endurance of the Chinaman, and are also deficient in energy, perseverance, and such like qualities, by the aid of which alone the arduous duties of a tobacco estate can be adequately discharged. A Chinaman, when treated with fairness and justice, will be found to be one of the most docile and tractable of God's creatures; submissive to constituted authorities, energetic, ndustrious, tenacious of his rights, resentful of a wrong, and with a keen eye to his own nterests, such are his chief characteristics. But even a Chinaman, with all these inherent qualities, would fall far short of the requisite tandard were it not for the admirable system f what I may term co-operation which exists n all the Sumatra estates, and which gives im a strong personal interest in the work he oes, and in the success of the undertaking hich employs him. The labour system in ogue in Sumatra is not, as far as I can scertain, adopted in any other country except orneo, and one or two other places where ey are attempting to plant tobacco on the umatra model. It perhaps more closely sembles the system of con-acre adopted in ome parts of Ireland than any other. The bourers are recruited in China by agents of e Deli Planters' Association, and forwarded Sumatra by direct chartered steamers. mmigration into Sumatra is practically free cost to the immigrant, only a small nominal m being charged to him for passage money, hile the bulk of the expense is borne by the anters. On arriving at his destination, and ntracting to serve on an estate, he receives cash advance to enable him to indulge his petite for roast pork and his passion for mbling. His money finished, he settles wn to a year's hard work. Each coolie allotted a field (about 1⅓ acres), which must prepare for cultivation at his own pense, the estate providing the necessary ads, main drains, and buildings. The jungle cut by natives of Sumatra (Malays or ttaks, the latter being independent tribes abiting the hills in the interior of the and), but the cost is charged to the coolies. the dry season — the first two or three nths in the year — the coolies lop the branches off the prostrate trees, pile them up against the trunks, and, when thoroughly dry, set fire to them. By this means the stoutest trunks of trees smoulder away until reduced to ashes, which, when distributed over the ground, constitute a very valuable manure. Then follow the successive stages of hoeing, planting, topping, and reaping, and gathering into the sheds. During all this while, the coolie being a penniless creature, the estate has to provide him with cash advances sufficient to buy his food (rice, fish, and pork; enough for himself, and something over to propitiate the devils whom he worships); his opium, which the strongest coolies all indulge in in moderation, apparently to their physical advantage; and his Chinese bombs and crackers, which he discharges in front of his dwelling on holy days to scare away the evil spirits which his belief teaches him are for ever on the look out for him. His clothes are but a small item of his expenditure, a dish-cloth round the loins and a broad-brimmed straw hat being, from his point of view, all that convenience and modesty demand. On holidays he pays a little more regard to the adornment of his person. In addition to these advances the estate provides him with all his tools and implements, with tea, in order to induce him to boil his water rather than drink it in its pestiferous state when drawn from wells or ditches, and even with a barber to shave his chin and head clean, with the exception of his pigtail. These various sums are put to the debit of his account, tea, by some of the more generous employers, being omitted from the calculation. The tobacco produced in his field and delivered into the drying sheds is purchased from him at prices ranging from $1 to $8 per 1,000 plants, according to size and appearance, and the proceeds placed to his credit. By the new method of harvesting which has come into vogue of late years—that of plucking the leaves as they ripen instead of cutting the whole plant—the coolie is paid according to the number of leaves gathered from his field, the difference in the mode of calculation working out slightly in his favour. At the end of the crop his account is balanced, and if the price paid him for his tobacco exceeds the amount of advances he has received the balance is paid out to him; if he remains with a debt to the estate he must work for another year, though the contracts don ot compel a coolie to work for more than three years with the same employer, even though at the end of that time he be in debt to the estate. From this brief review of the labour system which obtains in Sumatra it is most evident that a Chinese coolie on a tobacco estate works under more favourable conditions than others in his station o life.

Fig. 1.



Ripe Tobacco in the Fields.

The advantages of his position are manifest. A piece of land is allotted to him, for which he pays no rent. He enjoys an annual lease, which is renewable from year to year, for any length of time, as long as he has the health and strength to cultivate his field with profit to himself, which means also profit to his employer. He is furthermore provided with capital to work the land, with a free dwelling, free medical attendance, and, above all, with a market for his produce, his employer being bound by contract to purchase his produce from him for prompt cash.

One has but to visit the country, and see the coolie at work, to become convinced of the evident advantages of this system. He not only labours hard, in the heat of the sun, for ten hours a day every day in the month except two, but he may frequently be seen out in his field on moonlight nights, hoeing the land of his own free will. He is evidently under t influence of what political economists te the "magic of property." It is true t actual land does not belong to him, but t produce does, and, what is more, he certain of obtaining a fair price for The whole system gives him a vital inter in his work, and produces results imp sible of attainment where the labourer wo for a fixed remuneration. The system, far as I know, has but one disadvanta which is that under it the interests of the Eu pean planter and his coolies are, at one peri directly antagonistic. The planter works quality, and experience has taught him t healthy, well-nursed, and fully-develo plants must be planted out at regular interv which are determined by the capacity of soil. The coolie is compelled by contract plant out in rows 3 feet apart and at distan of 2 feet between each plant, but even the most conservative companies have made concessions on this point, and the general rule now is to plant from 18 to 20 inches apart. The European, therefore, only wants to get a certain number of plants from a given acreage. The coolie, on the other hand, being paid according to quantity, that is so much for every thousand plants he brings into the sheds, is naturally interested in planting as much as possible. He, therefore, exerts all the wiles of which he is a master to steal an inch of ground here and an inch there, as a Chinaman would no more think of laying him down to sleep at night without having cheated his master, than a pious Mahommedan would think of partaking of his meals before having performed those ablutions recommended by his Koran. There s very little of the Altruist about a Chinaman, I assure you; he worships Self and the Devil, and in the course of time the two become merged into one. This opposition of interests not infrequently leads to open conflict between he white and the yellow man, but it is regarded as one of the supreme tests of good management that such disagreements should not occur at all, or if they do, that they should e speedily adjusted.

Now, you may ask, what has all this to do with India? My reply is, that if you would mprove the quality of the tobacco produced n India, you must study to improve the methods of cultivation, and you cannot do better than imitate the example of the most prosperous tobacco-producing country in the world. I have, to the best of my ability, escribed the three conditions necessary to a uccessful cultivation. I have shown the part which each one plays, and I have instanced ow and to what extent each constituent is pplied in Sumatra. The slow growth of the ndustry in India, compared with other ountries, appears to me to be attributable ather to a lack of individual enterprise than to ny permanent defects in the available natural gents. The climate in some of the tobacco istricts is all that can be desired. The soil roduces in abundance, yet, of that coarse, hick-ribbed, pungent tobacco, which is quite nsaleable in Europe. The exports to Europe re too insignificant to be worthy of mention. et, compare this with the growth of the ndustry in little Sumatra.

In 1864, the first year of the cultivation in umatra, there were produced 50 bales, which alised the gross proceeds of £330. In 1874, 2,895 bales realising £237,000. In 1884, 125,496 bales realising £2,295,000. In 1894, 192,767 bales, which realised close on £3,000,000 sterling. These figures afford sufficient evidence of the existence of a large, increasing, and lucrative market in Europe for tobacco of a certain description. How to obtain such tobacco is well worthy the attention of the Indian authorities. It is most evident that the soil of India can never be so improved upon as to render it capable of producing the fine wrapper leaf of Sumatra. Did it possess such qualities it would long ago have produced some more satisfactory leaf, even though the system of cultivation had continued to be unsatisfactory. But even if the Indian soil cannot aspire to the perfection of Sumatra, still much can be done to improve it by the use of appropriate fertilisers, by giving it the necessary rest, and by an improved system of drainage. By more attention to these particulars, an improvement could certainly be effected, though it is to what I have styled the "movable factor," that is labour, skilled and otherwise, that the Indian tobacco industry must look for its regeneration. I have given instances of estates in Sumatra which were unremunerative until a change of management made them a source of immense wealth to their owners. If this can occur in Sumatra, then why not also, may I ask, in India?

It is absolutely impossible to teach the art of tobacco planting within the limits of a paper such as I have now the honour of reading to you, because, assuming my hypothesis that a planter is made, not born, to be a correct one, it follows that for the best part of his education he must rely on his experience and observation. Much good, however, may be done by pointing out glaring faults in the system of cultivation where they are known to exist, as it may lead to the avoidance of such faults in the future, and the consequent improvement in the results obtained. One of the weakest points in the Indian system is unquestionably that of labour. The cultivation is too much—nay, it is almost entirely in the hands of the natives. In Sumatra, a good deal of tobacco is grown by the native inhabitants, but it is a matter of common experience that such tobacco is in every respect inferior to that produced under European supervision. Not a leaf of the native grown tobacco in Sumatra finds its way to the European market, yet it is produced from the identical soil, and in an identical climate. Therefore the remaining factor—

"labour"—must be held accountable for that vast difference which is observable in the quality of the native and European-grown tobacco. The force of this factor becomes again most convincingly demonstrated, when we see a European, trained and skilled in his art, producing a very high-class article, where an ignorant and indolent native—all other conditions being similar—invariably fails to do so. Anyone who has had an opportunity of observing and studying the native races of Eastern climes, in the capacity of agriculturists, can hardly have failed to observe how rigidly conservative they are in their methods; how opposed to anything in the nature of an innovation, and how reluctant they are to the adoption of improvements.

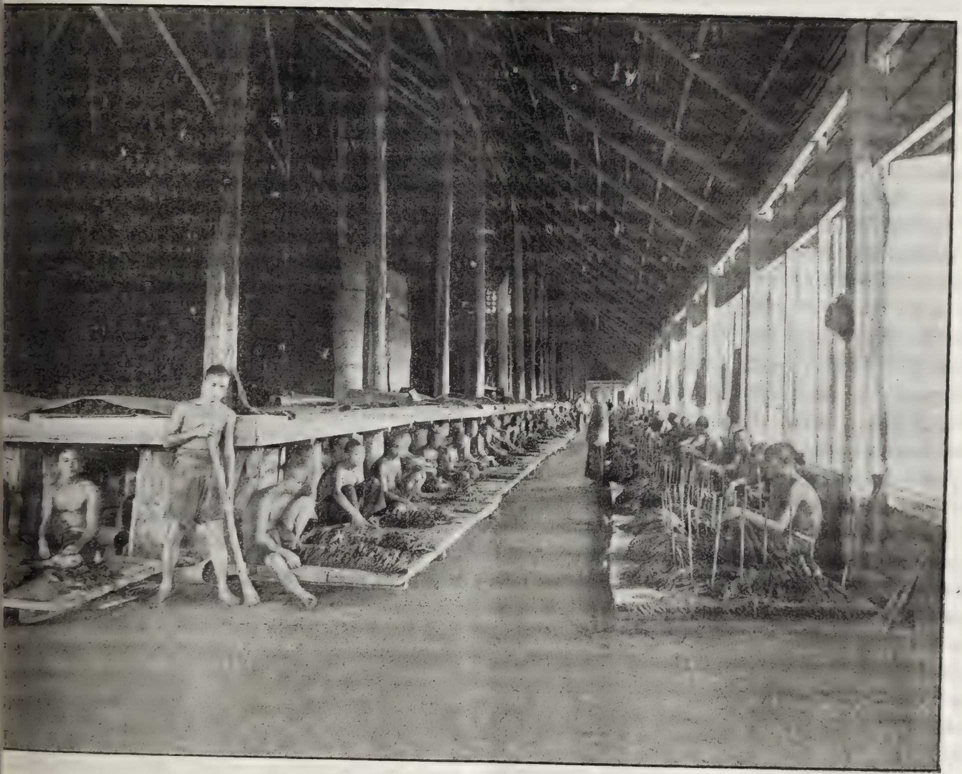
Tobacco was produced on the east coast of Sumatra long before a European ever set foot there; but it never found its way to any European market. Thirty-years ago an enterprising Dutchman made the experiment of planting on a more scientific system. The export trade was then only valued at a few hundreds sterling; to-day it is calculated in millions, and yet the native inhabitants adopt the same methods and the same system of cultivation to-day as obtained fifty years ago. Blind to facts, deaf to advice, they persevere in their old style, son copying father, apparently under the pleasing impression that they are right and the white man is wrong, and knows nothing whatever about it. I may point out two instances, from among others, where the native system in India appears to be radically at fault, one is in what is known as the "topping" of the plant; that is, breaking off the buds or the blossoms at the crown of the plant, to prevent it from flowering, which obliges a portion of the sap taken up, to be expended in the increase of the substance of the leaves. In India this topping process appears to be performed too early in the life of the plant, and before it has developed the full number of leaves which it could be expected to support. The plants in India are topped at a height of 1 to 1½ feet, the utmost length of stem rarely exceeding 2½ feet, whereas in Sumatra the commonest height is 4 to 5 feet, and even this is frequently exceeded. In India the topping is regulated more by height than by regard for the apparent strength and vigour of the plant, the object being to throw as much substance as possible into the leaf. The object is gained, but with questionable advantage, as it is just the weight and the coarseness of the Indian leaf that so militates against it, especially in countries like the United Kingdom, where the Customs' restrictions are so severe. In Sumatra, the topping process is delayed to the very last moment, the object of the planter being to distribute the substance of the plant among the greatest possible number of leaves, whereby he obtains that fine, silky, elastic leaf, for which Sumatra is celebrated, without in the slightest degree prejudicing its size or shape. Furthermore, the Sumatra leaf loses from 10 to 15 per cent. in weight while in process of fermentation. The next, and the last delinquency of the Indian system to which I shall refer is the custom, prevalent in some districts, of leaving the plants after they have been cut down, ou
in the fields for a whole night, exposed t
the dew. This custom would simply shock
Sumatra planter, who knows what an enem
damp is to tobacco, and who will only allo
reaping operations to be performed in dr
warm weather.

It appears to me to be a mistake that is pre
valent throughout India, of allowing the newl
reaped tobacco too much exposure to su
and light, to which may be attributed th
mottled, uneven colours which render the le
quite unfit for "wrapper" purposes. Th
process of fermentation, too, appears to
but imperfectly understood, and its impor
ance imperfectly appreciated. The knowledg
possessed by the native cultivators of this vit
process is of the most rudimentary descriptio
and amounts to little more than hanging t
leaves out to dry. Thorough fermentation d
stroys all organic substances in the plant, a
hence it is that the cured tobacco of Hava
and Sumatra is found to be perfectly free fr
the weevil, or insect pest, to which the cig
made of the unfermented tobacco of India a
found to be so peculiarly liable. I might menti
numerous other instances of striking differen
between the methods pursued in India a
Sumatra, but I think the "topping," "drying
and "fermenting" processes, to which I ha
alluded, are in themselves sufficient to accou
to a great extent, for the distinct inferiority,
every particular, of the product of the form
compared with the latter, country.

If further illustrations are required of
reluctance of native cultivators to adopt
methods, we have only to turn to the prin
reports of experts whose experience lies enti
in India. Mr. Broughton writes:—" From
experience of the natives of the Madras Pr
dency, I do not at all think they would fol
any improved method of dealing with t
tobacco, unless, indeed, a pecuniary advant

n the change could be made immediately pparent to them in their narrow experience. ubstantial proof would, I think, be necessary, f the money advantage to be obtained before ryot would voluntarily alter the current ethod of manufacture which has so long een pursued in this district." Messrs. Camp-ell and Co., of Dindigul, who have had several ears' experience in the preparation of tobacco, specially for the manufacture of cigars, thus xpress their opinion :—" As the tobacco gar-eners in Southern India cultivate remarkably well, but fail in the curing, we have long recognised the fact that as in indigo planting, so with tobacco, the produce should be raised by natives, and the curing should be done by Europeans." Mr. Tucker, in a note on the statistics of the trade, says :—" The principal barrier against a larger trade lies in the ignorance of the natives of the art of curing the leaf. A sufficiently profitable market might be found for ordinary Indian tobacco if it were properly cured." The following extract is taken from the Madras Manual of Admini-ation :—" The tobacco grown in this Presi-cy is at present inferior, but it seems clear t is mainly due to the fact that there is a at demand for the coarse article, and that is found to pay better to grow a large ntity of inferior leaf than to grow a smaller ntity of superior leaf." This, I may state, n direct opposition to all experience gained Sumatra, where, at the present time, it is the invariable rule of the planters to work for quality rather than quantity. Good tobacco is gold; bad tobacco is copper. I have known instances of estates which have produced fourteen piculs of tobacco per field, the proceeds of which have not repaid the cost of production; these same estates later on, and under different management, have produced eight or nine piculs per field only, but have

FIG. 2.



IN THE FERMENTING SHED.

Chinese Coolies Sorting and Bundling Tobacco. Stacks of Tobacco Fermenting on Platform.

realised enormous profits. The report goes on to say:—"European capital would, however, doubtless improve the curing process." I could quote numerous other extracts from the reports of experts who have studied the question. There appears to be a consensus of opinion that the system of cultivation now in vogue in India is out of date, faulty, and slovenly to a degree; that no improvement can be expected if the natives are left to their own initiative; and that if ever the cultivation of tobacco is to be brought to a state of even tolerable efficiency, the importation of capital and labour from the West is a preliminary condition of such improvement. I most thoroughly concur in these views. In fact, I go so far as to say that Indian tobacco is never likely to become a marketable commodity in Europe, until such changes as I have indicated have actually been adopted.

Some few years ago, a small quantity of Sumatra tobacco was sent to India in order to test the results obtainable from cigars made of Indian fillers and Sumatra wrappers. The experiment proved beyond a doubt that such cigars were not only vastly superior in appearance to those of entire Indian growth, but that they were also far more acceptable to the European taste. Since that time the Sumatra wrapper leaf has been gradually growing in favour with Indian cigar manufacturers, who are unanimously of opinion that the blended cigar is infinitely more palatable than one made entirely of the native product. Although I myself am more directly interested in the product of Sumatra, that does not hinder me from taking a very lively interest in the improvement and the expansion of the industry in India, believing, as I do, that the two countries may in course of time mutually contribute to each other's prosperity. India can never aspire to produce the delicate wrapper leaf of Sumatra, but India may aspire to produce a tobacco which shall be worthy to be clothed in the silky product of the Dutch settlement. At the present time it does not pay to cover the vast bulk of Indian tobacco with Sumatran, because the rank coarse flavour of the filler would vitiate and destroy the influence of the very choicest wrappers. The high values ruling for choice Sumatra leaf makes it a matter of conjecture how manufacturers can afford to employ it for cigars of decent interiors, and at the same time be able to sell the cigar at a reasonable figure. An American dealer of considerable eminence attempted the other day to solve the problem. The choicest American cigars are now covered with Sumatra leaf, which costs the importer from 15s. to 20s. per pound duty paid. Some disparaging remarks were made as to the quality of the tobacco which must be put inside this costly cover, and the cool, calculating American defended his industry by putting the following interrogatory to his questioner:—"Look here! If you see a man with a good coat on his back you don't also expect him to have a clean shirt on, do you?" Now, that may be all very well for America but it will not do for England. The British smoker pays considerable regard to the appearance of his cigar, but he also attache still more importance to its flavour. He, unlik our American friend, expects that both th coat of his friend and that of his cigar shall b an indicator of the quality of the materia underneath it, and if India is seriously desir ous of catering for his wants, she must look t supply underclothing worthy of the covete outer apparel of Sumatra.

In one respect, and one only, India has th advantage of Sumatra, and that is in the cos of production. It may startle those engage in the Indian tobacco industry to hear tha Sumatra cannot be sold much under 1s. 4d. pound without loss. The cause of this enor mous cost is principally to be found in th unaccountable policy of the Dutch Gover ment, which apparently offers objections rath than inducements to immigrants to remain an settle in the country which they have temporari elected to live in. Chinamen are the objec of a Dutchman's special aversion, not bein permitted to own land in Sumatra, ar being in other respects treated as if they b longed more to the canine than the huma species. Even the natives themselves are n permitted the enjoyment of equal laws ar equal rights with the Europeans. Wh motives the Dutch Government can possib have for such a policy it is impossible say, except it be their desire to grat the vanity of a handful of Europeans, who ambition it is to be the sole proprieto of the soil. It would be contrary to the la of nature if any alien races were to desire settle in a country under such disadvantageo circumstances, and their only possible moti in going there at all is to avail themselves the high rate of wages ruling there, and make money and invest it in some coun where they can enjoy equitable laws. T planter bears the onus of this mistaken poli as he must for ever be importing labour at cost which would be absolutely prohibit were it not that he is engaged in an exceptionally lucrative industry. There is a continual stream of immigration and emigration going on at the expense of the planters. Coolies come, and coolies go, but coolies never attempt to settle in the land where they have made money. A number of the immigrants from China are in a position, after a few years work, to retire on what, to them, is a small fortune, and they return with it, either to their own country, or else to the English settlements across the the Straits of Malacca. Now in this matter of a practically exhaustless supply of good, cheap labour, India has a distinct and a decided advantage over Sumatra. It only remains, therefore, for the Indian planter to pay a little more attention to detail, to apply a little more energy and a little more skill to the tobacco industry, and there is, apparently, no reason why, with the facilities he enjoys for obtaining labour, he should not rival the profits of the Sumatra industry, though, in all probability, he will never obtain as high a value for his produce.

In British North Borneo the tobacco industry must be considered still in its infancy. The initial effort to grow tobacco there was made eight years ago by some planters from Sumatra. They have had all the hardships and difficulties of pioneers to contend against, and most of the original planters have succumbed to their reverses. Their first enemy appeared in the form of a deadly fever, common to all new countries where jungle land is being cleared for cultivation. Half of the workpeople, both European and native, were swept away by this pestilence. The severity of this epidemic, and the disastrous consequences to those who had their capital in Borneo was succinctly explained by the chairman of a Borneo Company at a recent meeting of shareholders. Asked by a disappointed shareholder to what causes he attributed the failure of the company to realise the results anticipated in the prospectus, the chairman replied that he attributed their failure entirely to the fact that the company had been formed for the purpose of planting tobacco, whereas they had only succeeded in planting coolies. This epidemic passed away, and Borneo became every bit as healthy a resort as Sumatra; but a new enemy appeared, in the form of climate. The climate of Borneo vacillates between droughts and deluges, the planters there not being blessed with that "gentle rain from heaven" on which their more fortunate colleagues in Sumatra can reckon with an almost absolute certainty. The rivers, by which Borneo is so plentifully watered, swollen by the rains, have been known to rise several feet in a single night, and, bursting from the confines of their banks, spread their waters over the whole adjacent lands, laying low the crops, on which so much care, capital, and labour have been expended. The ravages caused by these inundations are the principal evil against which the Borneo planters have to guard. This danger surmounted, Borneo may yet become a formidable competitor of Sumatra. The quality of the tobacco is excellent—every bit as good as that of Sumatra—but the misfortune is, that it has not yet been produced in paying quantities; the delicate flavour, fine texture, and excellent burning qualities of the Borneo leaf, bear testimony to the rare adaptability of the soil, and mark the country out as the Cuba of the East, so soon as the serious, but not insurmountable, obstacles, to which I have referred, have been removed.

Now, in order to summarise my whole argument, I must revert to my original proposition, that there are three essential factors to the successful pursuit of the tobacco industry—soil, climate, and skilled labour. Sumatra possessing all three in a eminently favourable degree, is enjoying an amount of prosperity which is perhaps unequalled in any other portion of the globe. India's natural advantages of soil and climate, though inferior to those of Sumatra, may be turned to excellent account if skill, experience, and more capital are bestowed upon the industry. The further advantage possessed by India of an abundant supply of native labour, of which neither Borneo nor Sumatra can boast, ought, if skilfully utilised, to give her a place among tobacco-producing countries to which she has not hitherto become entitled. Then comes Borneo with a luxuriant soil, with labour conditions similar to those existing in Sumatra, but the victim of the elements, which, however, can, to a great extent, be guarded against by a more judicious selection of land for the purposes of cultivation. If the planters of India and Borneo would only pay more attention to those factors in which they are deficient, I feel convinced that they can improve the produce to such an extent, that it will in time become a source of wealth not only to themselves, but to the countries within whose areas their estates lie.

And when the produce of these countries has been brought to the required state of perfection, it may not be inapposite to reflect upon its ultimate destination. After all, when one comes to consider it, the tobacco industry all ends in smoke; but before it loses its concrete form, it gives employment to a vast amount of capital and labour, mostly, I am sorry to say, of foreign origin. Cuba and Manilla belong to Spain, and employ principally Spanish labour and capital; Java and Sumatra belong to Holland, and employ principally Dutch labour and capital. India and North Borneo are portions of the British Empire, but they do not yet rank as tobacco-producing countries of the first-class. They will, however, one day become so, and then we may see cigars grown on British soil, with British capital, and made by British hands. It is impossible to estimate what a vast field may one day be opened up for home labour and capital. We are becoming year by year, more and more a cigar-consuming people. The choicest cigars, but those far beyond the reach of a man of ordinary means, come from Havana, and to Havana, I fear, we must now, and for some time to come, yield the palm. But who caters for the wants of the average smoker of average means? The Continent of Europe, for the most part, which sends us something like 80,000,000 of cigars every year. But why this should be, when we have at home manufacturers able to turn out as good, if not better, cigars than those coming from the Continent, it is difficult to say. In the United Kingdom the manufacture of cigars can only be carried on in licensed premises which, under the factory acts, necessitates special regard to sanitary surroundings and daily supervision by an excise officer; whereas, on the Continent, many if not all of the cheaper grades of cigars are made actually in domestic garrets or cellars, without the slightest regard for the healthy and cleanly surroundings of the operatives. One would think this fact alone sufficient to prejudice British smokers in favour of the home article, but quite the contrary. The truth of the matter is, the average British smoker is as much impressed in favour of a Continental cigar as ladies are impressed in favour of French kid gloves, in both instances, to the disadvantage and almost complete exclusion of the home industry. In both instances, the wants of the consumer can be supplied at home; yet we prefer to patronise the foreigners. Why this should be, we do not know; we only know it is so. The Continental cigar manufacturer enjoys no advantage which the British manufacturer does not possess. The climate, which also has an influence on the manufacture—hence Havana's superiority—is the same; we have equal access to the markets of the world; the fingers of a British workman or workwoman are as pliable and as capable of twisting tobacco leaves into cigars as are the fingers of the Continent. Yet the bulk of the cigars consumed in this country come from the Continent. Why? Simply because our smokers are prejudiced. Simply because it is not the fashion, it is not considered good style to ask a man to dinner and offer him a British-made cigar afterwards. It is a fact that British cigars are purchased to-day, on condition that the labels on the boxes stamping them as such, are either altered or erased. These cigars certainly would not be dealt in if they were not of better value than those made on the Continent, yet the fact remains that they can only be dealt in profitably by practising a fraud on the consumer, and leaving him in possession of the pleasing belief that they are not of British make. The average smoker pretends he cannot enjoy a cigar made in London, yet give that identical cigar a Havana label and he will discourse for hours on its merits and delights. I have known more than one connoisseur deceived in this manner, much to his chagrin. I am afraid that—until it comes to be looked upon as a vulgar habit, the tendency to—

> " . . . praise in enthusiastic tone,
> Every century but this, and every country but one's own,"

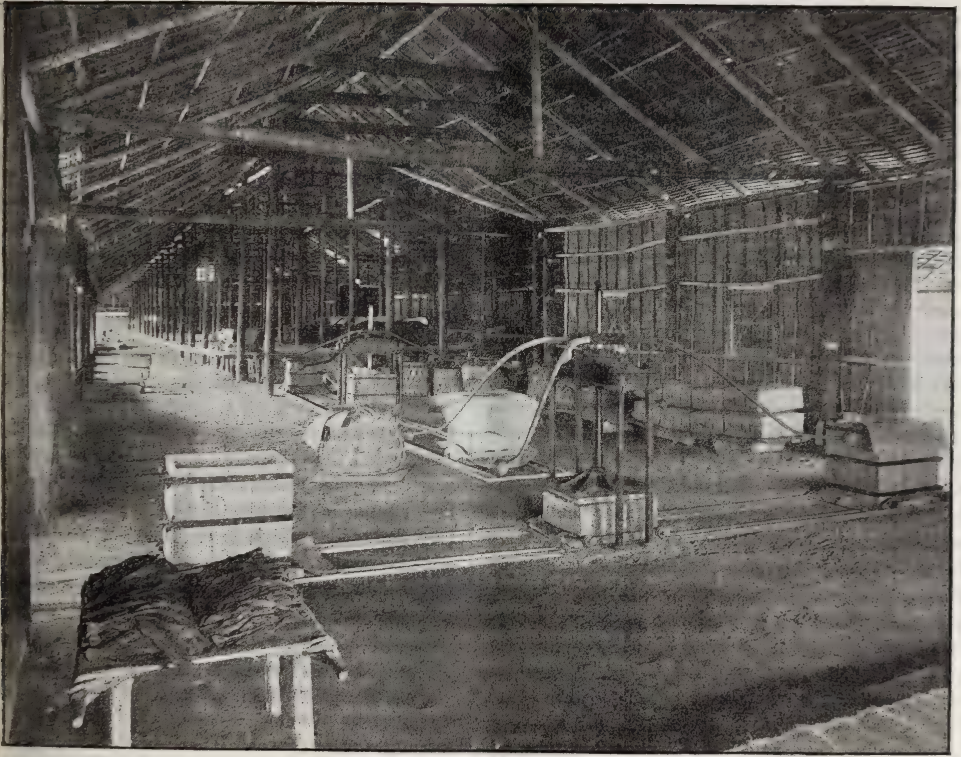
the British cigar manufacturer stands but a poor chance of holding his own against his foreign competitors. He, however, is not dismayed. He does not even raise the cry of the feeble for protection; he merely asks to be given an equal chance; to be allowed to start with his opponent at scratch; and then, in sporting phraseology, he undertakes to beat him hands down.

In spite of all the discouragement it meets with, I am glad to say the British cigar industry is making rapid strides. I regret my inability to give exact particulars, but the following extract from a letter I have received from one of our most successful and enterprising manufacturers may not be without interest. He writes—"I have not been able to get such complet information respecting the growth of the Britis cigar trade as I had hoped or expected. Th present number actually employed in makin cigars at the present time is from 9,000 t 10,000. This estimate does not include strippers, sorters, packers, and others necessar for completing the work, and who would pr bably represent an additional 15 per cent. to he foregoing numbers. There has been a considerable increase of late years in high quality tobaccoes used in this country for the purpose of cigar making, but what the actual amount or increase has been I do not think could be discovered. The quantity and value of British cigars has, I should judge, nearly doubled within the past twenty years, but at hat time there were so many employed in he trade who were not associated with any society, that it is impossible to give the actual ncrease."

These remarks open up a vista of a vast field for the employment of home labour, one of its most satisfactory features being found in the fact that the nature of the work is peculiarly adaptable to, and admits the employment of, female hands.

In conclusion, I may be permitted to entertain the hope that my remarks may reach those quarters where they will be of most value, and that this now nascent British industry may in course of time receive that attention and en-encouragement which it alone needs to render it capable of almost indefinite expansion.

Fig. 3.



Interior of Fermenting Shed.

Packing Tobacco.

DISCUSSION.

The Hon. C. H. Strutt, M.P., speaking rather as presenting the British tobacco industry in North orneo than as an advocate of Sumatra, had had peronal experience of what was going on. In the first ace, why should we have given up rich tropical counies like Java and Sumatra, although getting someing, perhaps not much, in return? It was difficult see why we should surrender valuable countries in the Far East. In the House of Commons the other night, Mr. John Burns found great fault with the British capitalist for employing "yellow labour" rather than British workmen, but the British workman consumed the tea, coffee, and tobacco produced by that labour, which was absolutely necessary for their production, as British labour could not be employed in the countries where those articles were produced. In Borneo and Sumatra was grown the wrapper tobacco for outside leaves of cigars. For that purpose the appearance and the quality of the article was of more importance than the taste; and the fact that great attention was paid to the good looks of cigars had practically made the fortune of Sumatra. He had been chairman of a company for growing tobacco in British North Borneo, and could not agree with Mr. Tripp's opinion that, with a soil inferior to none, tobacco could not be produced there in paying quantities. It had been produced in paying quantities. No doubt the requirements for successful cultivation were, first the land, then climate, and then labour. It was true that in some parts of Borneo they had suffered from floods; but it was an entirely new country, and as the only way of getting into it was by the rivers, the first land planted had been along the rivers, so that if the banks were not sufficiently high, floods during heavy rainfalls spoiled the tobacco crops. They were, however, now selecting land lying too high to be affected by ordinary floods, and they hoped in time to be able, in Borneo, as in Sumatra, to get the tobacco crops harvested before the rainy season came on to avoid risk of their being spoiled by floods. They had no reason to doubt that they would get over that difficulty, and that they would be in that respect on a par with Sumatra. Sumatra had the advantage over them of having intercommunication between large estates over a great tract of country. In Borneo the land fit for tobacco was more scattered. At first they could not get the pick of the Sumatra planters to help them, and the assistance they obtained was not of the very best kind. But during the eight years they had gone on those gentlemen had been eliminated, and they had now in Borneo men of such a class that they would be very sorry to change them. Mr. Tripp had said that managers of tobacco plantations did not require the brains of statesmen or journalists, but should have common sense, knowledge of mankind, ability to govern all sorts and conditions of men, the gift of organisation, and moral strength. Certainly the possession of all those qualities would go some way towards forming a good man of business. What was really wanted was common sense and enthusiasm. He had heard "shop" talked among men of many classes and vocations, but these was nothing like the "shop" talked by tobacco planters. One thing they were always certain of: that each year's crop was the best they or anybody else had ever grown, and they sent home correspondingly glowing accounts. Their enthusiasm in that respect might be well forgiven. Mr. Tripp had given an admirable description of coolies. There was something extraordinary in Chinese as compared with English labour. As long as they could see a dollar to be earned the Chinese would go on for a whole year and would then, if they had a few dollars over their cost of living, go to one of their gambling-dens and gamble their money away in a single night. They would not however cut their throats on that account, but would start work again the next morning for another year, with the prospect of another night's gamble at the end of it. Borneo did not get the pick of the coolies like Sumatra. Another characteristic of the coolies was that they liked to be under English employers. The captain of a coolie ship told him that at Penang 140 of them nearly mutinied on board because they believed they were not being taken to an English estate as agreed, but they settled down quietly when assured that that was to be their destination. When North Borneo became better known to the Chinese the planters would get over the labour difficulty and would then be able in all respects to start fair in their competition with Sumatra. In one respect they had the advantage of Sumatra, and that was in the flavour of their tobacco. For outside leaves good looks and not flavour were required; but they had two strings to their bow in Borneo, and if the wrapper trade went to pieces they could still rely upon the quality of their tobacco, as was shown by the growing quantity of it brought home to the English market for the manufacture of cigars. O course he would not claim that Borneo tobacco wa equal to the best Havana article, but he would sa that if a man who could not afford 8d. or a 1s. fo his cigar, bought Borneo cigars, they would affor him an excellent smoke, and he would still buy them when he got richer. Then as to Indian tobacco, i had the disadvantage that it would not make a prope wrapper at all. Possibly India would not be able t follow Sumatra too closely in competition on th tobacco market, but if Indian growers were left absolutely alone in the cultivation of tobacco it certainl would not be grown to suit European tastes. Tobacc growing in the East was not a pursuit which a ma should embark upon single-handed without considerable capital, for as he might have to wait three or fou years before he made profits, he might in that cas find himself at the bottom of his purse. He wa surprised when told that his company was the fir British formed for the purpose of growing tobacc on British soil, but of course many others ha followed their example. Care should be taken n to pay too much money in the selection of plo of land, and had he been chairman he should hav opposed the sinking of a large sum in that way b investors in Borneo. They had themselves pai nothing down at all. He believed that tobacc growing would be successful in the future if shar holders recognised the necessity of sufficiently loo ing after their own interests.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., sa the whole subject of tobacco had the profounde fascination for every one who had ever studied earnestly. Nothing indeed in the history of tl migration of plants, and of the transmission of habi of social indulgence from one nation to another, more extraordinary than the immediate, rapid, a overmastering success with which the cultivation a smoking, snuffing, and chewing of tobacco spre from the Americas, in the 16th and 17th centur throughout the whole of the tropical and sub-tropical regions of Africa and Asia; its cultivation, with its habitual dietetic use, having now even spread into the temperate and sub-arctic regions of the Old World, so far north as Norway, and so far south as Van Diemen's Land. This seems so incredible, that a traveller and naturalist so illustrious as Pallas, and a botanist so eminent as Meyen, have upheld the hypothesis that the cultivation and use of tobacco in India and China were more ancient than the discovery of the New World by Columbus. But it is now absolutely determined that both the pinkish-flowered *Nicotiana Tabacum*, the source of Virginian, Havanna, Latakia (Laodicea), and Manilla tobacco, and the greenish-yellowish flowered *N. rustica*, the chief source of Brazilian, German, Hungarian, Persian or Shiraz (*var N. Persica*), and East Indian tobacco, were absolutely unknown in any part of the Old World before the invention of the New. The truth is that it is difficult, after four hundred years of familiarity with the New World, to fully measure our immense indebtedness to it as a material and moral regenerator of the Old World. But its discovery came upon our forefathers like the descent of a new planet upon the earth; the impact of which among Englishmen, ignited the genius at once of Shakespeare, Bacon, and Raleigh. The vegetable physiognomy of the landscape of a great part of the Old World was, within one hundred years, completely modified by it. In their representations of Biblical and classical scenes our European artists still continue to introduce into them the cactus, the aloe, the "Farnesian Acacia"—Dryden's "Cassie sweet to smell"—and the maize, not knowing hat these are American plants, though now characteristic features of the scenery of all the countries of the Mediterranean Sea, and of the whole of Southern India. The wildest weed in India is the "Mexican Thistle." Along the sea shores of Western India, particularly of the Southern Concan, a predominant tree of the woods in the neighbourhood of the towns and villages, is the Cashew Nut. In such places the Custard Apple is also frequently found growing wild, and both are American trees. The cactus is a boundless blessing to the Old World, for it spreads rapidly over waste places, and, ceaselessly decaying there, restores humus to the soil exhausted and corroded by centuries upon centuries of civilisation. Turning to our own country, the "Lombardy Poplar," the "Weymouth Pine," and the plane tree, are all importations from North America. And what would our gardens be without their acacias and tulip trees, and magnolias, and the "Virginian Creeper," all American plants. The rustic gardens in South Devon and Cornwall are wonderfully beautified by the fuchsia and nasturtium; the latter reminding one in high summer time, as they blaze in orange and scarlet against the whitewashed cottages, of the bright glow of vegetation at Cadiz and Algiers. Both are American plants, and soare the ubiquitous humble potato the staff of Irish life, and the tomato, now almost naturalised both in Cornwall and Sussex. But none of these plants can be compared with the tobacco plant for the rapidity with which it overspread the Old World in the 16th and 17th centuries, and the blessings it has bestowed on mankind in easing their labour and cheering their leisure. It has a miraculous effect in taming savage man. The ancient Scythians were the ceaseless scourge of Hamitic (Egyptian), Semitic (Assyrian and Babylonian), and ancient Aryan (Indian, Persian, Greek, and Roman) civilisation. They are referred to by the prophet Jeremiah as "a seething caldron," ever boiling over in fierce and cruel eruptions from the North. Where are they now? They have become the modern Turks; and the magic which changed them from restless and destructive nomads, into the quiet and only too conservative sedentary Turks, Von Moltke tells us, in his "Letters from Turkey," was none other than the acquired American habit of smoking tobacco. As Byron sings in "The Island"—

> "Sublime Tobacco! which from East to West,
> Cheers the tar's labours and the Turkman's rest."

The yam, maize, and tobacco, were among the first five plants noted by Columbus in America. The smoking of tobacco was observed, in Cuba, while on his first voyage, 1492; its use as snuff, on his second voyage, 1494-6; and for chewing, in South Honduras, on his third voyage, 1502. The plant was first described by Benzoni, under the name of *petum*, in his "Nova Novi Orbis Historia," Geneva, and by Thevet, under the same name, in his "Les Singularitez de la France Antartique," Antwerp, both in 1558. *Petum*, or rather *petun* (as in *Petunia*) is its Brazilian name, while its English, and now universal, name of tobacco, is derived from the Haytian name *tobako*, of the pipe used in smoking it; first described by Oviedo in his "Historia de las Indias Occidentales," Salamanca, 1535. The plant, *N. Tabacum*, was first brought to Europe in 1558-9 by Francisco Hernandez ("Nova plantarum, animalium, et mineralium, Mexicanorum historia"), physician to Philip II. In 1560 the French Ambassador to Portugal, Jean Nicot, of Nismes, who gave the plant its generic name *Nicotiana*, sent some seeds of it to Catherine de Medecis, whence its first French name o "Queen's herb." At the same time the Papal Nuncio at Lisbon sent some seeds of the plant to Rome, whence its first Italian name of "herb St. Croix." Stow, in his "Chronicle," the second edition of which is dated 1600, says the plant was first brought to England in 1565 by Sir John Hawkins. It is certain that, in 1586, Sir Francis Drake and Ralph Lane brought over the Virginian tobacco, as prepared for smoking, and the tobacco pipe, from Sir Walter Raleigh's colony on Roanoak Island; and it was Sir Walter Raleigh who at the Court of Queen Elizabeth first set the example to all Europe of smoking tobacco; and he calmly smoked his pipe of tobacco on his way to the scaffold in 1618. It was apparently first smoked by "the general" in this country at the "Pied Bull" inn, Islington. The Jane Cakebread of tobacco was Mary Firth, immortalised in Middleton's "Roaring Girl," 1611. The habit of smoking tobacco, costly as it was at first, rapidly became popularised. But, strangely, Shakespeare (1564-1616) makes no mention of it, unless the "pouncet-box"* of 1 Henry IV., i., 3, is an anachronical allusion to tobacco snuff. Still more strangely, Cowley, who in his "Plants" (1656), describes the *coca* of Peru, says nothing of tobacco. This is an inexplicable omission. But already in 1579, Spenser, in the "Fairie Queen," praises it as—

> "The soveraine weede, divine tobacco."

And again, William Lily, in 1644, as "our holy herb, Nicotian." And already, in Warner's "Albion's England," 2nd ed. 1606, it is blamed as—

> "an Indian weed.
> That fumed away more wealth than would a-many
> thousand feed."

And Drayton, in his "Polyolbion," 1613, writes of it:—

> "Before the Indian weed so strangely was embraced,
> Wherein such mighty sums we prodigally waste."

And Burton, in the "Anatomy of Melancholy," 1614, in a well-known passage, too long to quote, at once exalts it to the skies, and abases it to hell. The attacks on it culminated in the "Misocapnos" of James I., 1619. He forbade the cultivation of the plant in England and Ireland, and the prohibition, repeatedly renewed and extended to Scotland, was only conditionally removed in 1886. But in spite of the Royal "Counterblaste," tobacco smoking became the fashion all over England, and from England the practice was carried into Holland, France, Germany, Russia. It was prohibited in Russia in 1634, and in France in 1635. It would appear to have been carried into the East by the Portuguese, who are known to have introduced it, in 1601, into Java, and in 1605 into Japan, where it was forbidden in 1612. It was first observed in India, in the reign of Akbar (1556-1605), and was prohibited by Jehangheer (1605-27). It was prohibited in Turkey by Amurath II., 1616; in Persia, by Abbas the Great (1582-1628), and in China by Kung Ching in 1641.† But nothing could check the propagation of the practice and the cultivation of the plant, and wherever the use of the drug spread, it has ever since been called by its English name, excepting only among the Arabians, who call it by a native name, meaning "smoke." The lasting delight of the East in their new found joy is shown by the number of descriptive poetical epithets applied to the drug, in addition to the unmeaning commercial name, tobacco. Thus in China and Japan *tan-pa-ku*, i.e., tobacco, is als phrased "the heavenly fragrance," the "queen her of the rude barbarian," "the divine root," "th blossom of fragrance," "the herb of long life," "th life strengthening herb," "the friend of leisure," "th herb of constant pleasure," "the herb of amiability," "the herb of love," "the herb of wise reflection," "the soul reviving herb." There are, however, tw depreciatory Chinese and Japanese names for tobacc "fools' herb" and "poverty herb," but these afte all are but proof of the fascination which smokin exercises as well over the foolish as the wise.* Th English first begun to cultivate tobacco in Virgini in 1616, under Sir George Yeardley; and by 16 the production of Virginian tobacco was 60,000 lb In 1689, 120,000 lbs. were exported from Virgini To-day the export of tobacco from the United Stat reaches 270,000,000 lbs. In England alone, the co sumption of American tobacco amounts annually over 75,000,000 lbs. The total output of the Unite States is estimated at 500,000,000 lbs.; and the tot area under tobacco there is over 700,000 acres; i cultivation giving employment to over 200,000 planter The present consumption of all tobaccoes throug out the civilised world cannot be placed und 1,250,000,000 lbs., and the approximate area devot to its cultivation may be calculated at 2,000,0 acres. Everyone, but a few stubborn fanatics, n smokes, and it would seem as if tobacco had inde been the secret force which drew the Old World the discovery of the New. No doubt the Old Wor was well prepared for the adoption of tobacco as smoking herb. From the artistic elaboration of t opium pipe in use in Japan and China I have be led to attribute a very high antiquity to it, wheth for smoking opium or any other drug, I will not h argue. Herodotus, I., 202, says of the Messaget who in this place may be identified as a tribe Scythians, that they possessed "a tree" bearing strange produce," which when they met together th cast into the fire round which they were sitting, inhaled its fumes, on which they got drunk just as Greeks did with wine. This "tree" was undoubte the modest hemp plant; for later, in Book I chapter 75, the historian informs us that the Scythi "intoxicated themselves by taking hemp seed, a reeping with it under their felt blankets (*namads*), nd throwing it on red hot stones, and inhaling the umes given off." Pliny, xxi. 69 (18), states that the oots of a species of cyperus were burnt by some race f unnamed barbarians, and inhaled for the reduction f enlarged spleen; again, xxiv., 84 (13), and xxvi., 6 (6), that the root of coltsfoot was smoked, s a remedy in cases of inveterate cough, by aid f a pipe—"infurnibulum," or "infundibulum"—hich apparently very much resembled the Haytian -shaped tobacco pipe; and again, xxviii., 67 (17), hat dry cowdung was smoked through a reed, as an lleviative in consumption; and, finally, that "real-ar," as he calls it, was inhaled as a palliative in sthma: Dioscorides adding, V. 122, that it was moked through a pipe. Again, it is said that a fox moking a pipe is represented on the armorial bearings arved on a stone chimney-piece in Cawdor Castle, ated 1510. If this is an unquestionable representaon of tobacco smoking in Great Britain before the ntroduction of tobacco into the island by Sir Francis rake, what are we to say to Skelton's lines, which ust have been written before 1529, the year of his eath:—

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* The "Tobacco-box" of the Post Overseers Society of St. Margaret's and St. John's, Westminster, originally presented by Henry Monck, 1713, owing to the ornamental augmentations yearly made to it by his successors in office, is, as a record of civic history, and of the painful vicissitudes of the art of decoration in this country, one of the most interesting sights of "London Town."

† Huc states that in China the sign of a tobacconist's shop is the conventional *fleur-de-lis* of old France, indicating, apparently, some connection between the two countries in the matter of the introduction of tobacco into the former.

* The following is a modern Arab legend of the origi the tobacco plant:—"The Prophet walking in his garden morning came upon a viper stiff with cold, and lying a dead, in the grass. Full of compassion he took it up warmed it in his bosom. But when the reptile recovered it him. 'Why art thou thus ungrateful?' asked the Prop The viper answered, 'Were I to spare thee another of race would kill me, for there is no gratitude upon earth. Allah I will bite thee.' 'Since thou hast sworn by A keep thy vow,' said the Prophet, and held out his hand t bitten. But as the reptile bit him the prophet sucked poison from the wound, and spat it on the ground. And there sprang up a plant in which the serpent's venom is c bined with the Prophet's mercy, and men call it tobacco.

> "Nor did that time know
> To puff and to blow
> In a piece of white clay
> As you do at this day,
> With fier and coal
> And a leaf in a hole."

It is true his works were first published in 1568, d Stow says that tobacco was first brought to ngland by Sir John Hawkins, in 1565; but three ears do not leave time for the practice of tobacco noking to have grown to such an extent in England to have led to the interpolation by a dishonest litor of these certainly puzzling lines in Skelton's oems. In America the smoking of tobacco proably goes back to the remotest traces of man on at continent. The mounds of the Ohio and Scioto alleys, so abound with red stone tobacco pipes, at one of them is named from these relics of early an as the "Tobacco Pipe Mound." It is well nown that among the North American Indians the noking of tobacco together is a most sacred pledge peace, and that the practice is intimately interoven with all their rites and superstitions, and cial habits and customs, and traditions and history. his no doubt is due in the first place to the fact that ter dreams, alcoholic and narcotic stimulants of all nds have played a most important part in providing ankind with intimations of the hidden spiritual life ound them, whence indeed the sacramental status these stimulants in so many ritualised religions. ut in the second place the sacrosanct status of bacco among the North American Indians is due to e peaceful, sociable, and benignant frame of ind induced by smoking the drug. Alcohol rinking promotes sociability, its supremest praise erbearing all its blame; but it readily betrays to intemperance. Opium smoking, though initely less harmful than tobacco smoking potentially is, and indeed absolutely harmless in itself, encourages unsociability and solitary habits; but tobacco smoking at once soothes and cheers and humanises, and promotes temperance, and it is only in extreme excess that it causes any evil effects bodily or mental. Pereira, Christison, and Parkes are all agreed as to the general innocuousness of tobacco smoking; while the universal indulgence of mankind in the habit is an unambiguous indication as well of its material as its moral benefits. Tobacco smoking, in a sentence, is health and virtue made easy. It is only to be regretted that in importing the habit from America we could not also have imported some of the religiously-binding diplomatic practices associated with it by the pagan aborigines of that continent. When a cause of quarrel arose among them, and they did not wish to fight over it, the chiefs of the opposed tribes exchanged pipes, and smoked together; and when tribes engaged in hostilities became tired of them, they brought them to an end with a good smoke together. The historical calumet of peace is indeed the most characteristic and the noblest symbol of the ancient race of Red Indians; and there is much need for its introduction into the diplomacy of the Christian nations of Europe. Nothing aggravates a quarrel more than exchanging notes over it; and it would be a decided improvement to substitute a change of pipes, or cheroots, or cigars, or even cigarettes. There will indeed never be a true and effective concert of Europe until it is converted into a smoking concert. And this leads me to ask, in conclusion, why Mr. Tripp's admirable paper on smoking was not a smoking lecture. The way in which the Imperial Institute mixes up in its programme the entertaining with the instructive has no severer critic than myself; but that is only in my official and public capacity, and as a private individual I like it; and must confess to a feeling of deep disappointment when I found on coming here this afternoon that pipes, cigars, and cheroots, those dear concomitants of "nappy ale," were not to be handed round during the reading of Mr. Tripp's paper, so that we might have practically pronounced on the merits of the rival brands of "East Indian" tobacco. But this unfortunate omission in no way detracted from the interest and high practical value of his paper. We have all listened to it with instruction and pleasure, and as a member of the Committee of the Indian Section of the Society of Arts I would add that we are all most grateful to Mr. Tripp for it. We believe it will do great good in attracting public attention in this country to the high merits of East Indian tobacco of every honest brand, and we hope that there is a future of ever-growing prosperity for the trade in it, both here and throughout Europe, and that the smoke of it will go up for ever and ever.

Mr. M. Mowat could testify that Mr. Tripp was thoroughly acquainted with his subject, having been associated with him since he joined the

British Deli and Langkat Company about two years ago. Tobacco was a very expensive crop to raise. The same land could only be used for one or perhaps two crops, as explained by Mr. Tripp, and their great expense was in having to use fresh fields every year, their returns, however, were now something like £120,000 per crop. A large amount of English money was invested in Sumatra companies, but Stock Exchange values to-day are not what they had been years ago, for the alteration in the American McKinley tariff had crippled many companies, and led them to cease cultivation. Still, however, a large sum of English money remained in Sumatra tobacco companies, but the quantity of tobacco landed in England by them was very small indeed. The annual value of the Sumatra tobacco trade with Amsterdam reached the large total of nearly three millions sterling, and what they would all like to see was their own country getting a larger share of this turn-over, say something more in proportion to the amount of capital England has embarked in the Sumatra industry, as well as her large consumption of the article. The industry was carried on chiefly by means of joint stock companies. A few Amsterdam concerns were paying cent. per cent., and their shares stood at very large premiums. That was because the Dutch were the pioneers of this industry, while the English only came in towards the end, after the Dutch had proved the value of their properties; but field for field, and estate for estate, some English-owned properties would compare favourably with the Dutch. At present, the Indian tobacco trade was small, but there had been a decided improvement in the cultivation during recent years. In place of the long Trichinopoly cigars—with a straw through the middle—of some 30 years ago, we now saw in tobacconists' shops the "Flor de Dindigul," which in shape were quite equal to Havana cigars. Probably India would never grow such fine tobacco as Borneo and Sumatra, which lay nearer the equator, within the region where the finest wrapper tobacco was grown. No doubt a great improvement might be effected by having English cultivation. Mysore and Ceylon plantation coffee, for instance, always commanded a greater money value than the native article. He was glad to learn that an enterprising English or Scotch firm was about to take Indian tobacco planting in hand; and trusted that success would attend their efforts. It was a great pity we did so little in the direction of British-made cigars, seeing the large consumption in this country, for we get the raw material readily to hand, and can manufacture easily; indeed, we ought to have something like a monopoly of that trade. Borneo cigars were no doubt good, and were sold at cheap rates; but equally good cigars, with a Sumatra cover, could readily be bought in London at 2d. or 3d. More enterprise in the trade would be advantageous for all concerned. Although the Imperial Institute and Society of Arts, as referred to by the last speaker (Sir Georg Birdwood), had not got tobacco samples, he woul be pleased during the forthcoming year to suppl them, and he trusted that by bringing such important matters before the Society of Arts it migh be for the benefit of British trade.

Mr. REGINALD M. APPLIN desired to add a fe words on the climate of North Borneo. As th lecturer had said, a wave of disease would occasionally sweep the coolies away; and he had a theor in reference to the malaria which had those fata effects. He was in the service of the Chartere Company, and had travelled in different parts of th interior, but never had more than a few days' illness and had only discovered on returning home wha it was to have a bad climate. When the Crow Colony of Labuan was first taken over, people died i hundreds, and the men-o'-war lying in the harbour los half their crews. At great expense, the Governmen cleared some 3,000 or 4,000 yards of jungle along th coast and the shores of the harbour and the malaria disappeared as if by magic. The same thing held goo on the estates. Go into the jungle and they ha malaria. Cleared spaces seemed to drive the malari away even from the surrounding jungle. Practicall that was what had been done, and he thought ver little more would be heard of disease among th coolies in North Borneo. Difficulties arose fro flooding along the rivers; but the estates woul now be away from them, and the British Nort Borneo Government were now shipping out rails f a light railway right across the country, and a telegraph line was being made to a district which coul not possibly be flooded. An experimental esta had been opened by the British North Borneo Gover ment in the far interior. It was in the most perfe plain for cultivation that could be wished. An exper enced planter who was sent up there with 20 coolie obtained help from the wild tribes living on the spo By coaxing and a certain amount of moral persuasio he got them to plant tobacco. Though in an exper mental stage, tobacco fields were now plante in the interior. When the native labour of t country could be utilised the necessity for en ploying Chinese would be done away with. O his return home he tried the Borneo Sta cigars and found them perfection, British cigars i every sense of the word, grown on British soil an made by British hands. They had been told by M Tripp that on one side at Serdang the soil was pe fectly adapted for growing tobacco, but not on t other. He did not know whether that soil had ev been analysed?

Mr. TRIPP said it had, and the two soils had bee found absolutely different, so that special fertilise were required.

Mr. APPLIN, in reference to the cruel treatment coolies by the Dutch, said that in British Nor Borneo special officers were appointed for their pr ction. When first brought over they were taken fore him, their names were entered in a book, and ery means were afforded them of communicating ith the authorities. The slightest case of cruelty as reported, and several of the masters had been verely punished for ill-treating coolies. The British orth Borneo Government encouraged coolies to ttle down there, and 3,000 Chinese Hakkars were ready in Kudat, a small monthly sum being anted to Chinese settlers, which they repaid or not they could.

Mr. C. Krishna Menon, of the Madras ollege of Agriculture, said that he had on veral occasions been deputed by the Indian overnment to visit the tobacco-growing dis- icts of Southern India. His remarks would be nfined to Indian tobacco growing, particularly in adras and the two places, Trichinopoly and Co- nada. The cultivation was now of the very best though at one time he thought it defective—and e finest tobacco fields he had ever seen were in uthern India. Whoever spoke of bad cultivation India was ignorant of tobacco growing in Madras. actical knowledge was shown there in selecting itable lands; and the water used, a most important int, was excellent. Nitrate of soda and saltpetre, e very things wanted in the cultivation of tobacco, re contained in the soil. Considerable improve- nt had been made in curing. He felt sure there s ample scope for the development of the trade. No ubt a prejudice existed against Indian tobacco, but would be overcome and the article would in time come popular and be used, just as had happened in e case of Indian tea, which had to a large extent sted the Chinese article from the market. Indian baccoes properly cured would make the best possible lers. Elaborate experiments had been made the farms, and if the planters would only lect the broad leaves separately for curing, they uld succeed better. The best of the leaves were oiled by mixing all the leaves together in the pro- ss of fermentation. Men of practical knowledge d experience should be sent out from India to matra to learn better methods of curing. At esent they were only on the fringe of the whole estion. Experienced practical tobacco curers knew w important the water supply was for tobacco ltivation, and agricultural chemists would be able give planters valuable information. All that ant expense to Government, but the English Gov- nment, like English landlords, was bound to assist carrying out improvements, and for that purpose make experiments down to the minutest details. e could, he was afraid, hardly expect anything like at was done in that direction in France. In Mad- alone there were nearly 2,000,000 acres fit for e cultivation of tobacco which had not yet been uched. For prospecting companies doing business India, who would carry out such suggestions in an ganised way, a splendid field was offered. Labour, the cheapest in the world, could be obtained there for tobacco culture. The total cost of raising a pound of tobacco would not be more than sixpence.

Mr. Baron Elkan (as a member of the firm of Bewlay and Co., who first introduced Indian cigars into this country) said it was generally acknowledged that a cigar made from high-class Indian fillers, blended with a Sumatra wrapper of fine quality, was one of the nicest cigars that could be smoked. Good Sumatra tobacco was suitable for wrappers, being smooth and nice in appearance, while good Indian tobacco, well blended, was most suitable for fillers. A good Indian cigar depended upon the blending, and in this respect resembled somewhat the Egyptian cigarette. He was glad to say that European methods were being employed in India in both the cultivation and curing of the tobacco, and also in the manufacture of the cigars, and although the trade was yet in its infancy, enormous progress had been made in a few years, and it had now reached a stage when great things might be looked for from it. The smoker of Indian cigars was supporting an important industry in our Eastern Empire, which could not be other than productive of good results.

Mr. G. F. Freeman said he would speak, as a cigar manufacturer, from a somewhat different point of view to that of those who had already addressed the meeting. The subject was of peculiar interest at present, inasmuch as the London Chamber of Commerce had had some inquiry made within the last week or two as to the best methods of growing tobacco in various places. The only advice that could be given was that planters must analyse their soil, and study what was most suitable for their climate; but, above all, they must get proper experts to grow their tobacco. It was of no use to employ persons in the cultivation of tobacco as if they were growing cabbages. That might have done very well in the old days, but it would not answer in the present state of competition in the market. He was certainly of opinion that British manufacturers could make a better combination out of the different tobaccoes than any manufacture by the growers themselves. Whatever advantages Indian tobacco possessed it would always suffer from the presence of a large amount of inorganic substances, which would be against it in the market, unless got rid of. Whether they would be found to be removable or not he did not know. It would also be an advantage if this tobacco were allowed to come in under a smaller duty; but the removal of the objection was certainly necessary.

The Chairman thought, as the advocates of Borneo, Sumatra, and Madras tobacco had had their say, the discussion might be brought to a close; but he would add a few words about tobacco-growing in another part of the world. Some ten years ago he introduced the subject of tobacco cultivation in

England in the House of Lords. In an extremely successful speech, from his own point of view, he proved satisfactorily that tobacco had been grown in England in large quantities per acre, and had been sold in England at prices which led to the conclusion that it was a profitable article of cultivation. It might be news to some present that the cultivation of tobacco in England was at one time an extremely profitable undertaking. That very practical man, Oliver Cromwell, found it necesary, objecting to tobacco as much as James I., to issue a counterblast against its cultivation, but he did it in a more practical way than the first Stuart, by sending his troopers out among the tobacco crops and cutting them down. That was in Gloucestershire in a district where fruit had been grown by Lord Sudeley. The same cultivation had also been carried on at Richmond, where a few years ago a crop of chicory was grown; also in the south of Ireland, and it had been shown to be possible in Scotland. But the statute against it had never been repealed, and to this day a fine of £2,000 per acre might be imposed for growing tobacco, with destruction of the crop. After his remarks in the House of Lords a great deal of interest was taken in the subject, and a few of his friends, Mr. Faunce De Laune, Lord Walsingham, and other practical agriculturists took it up in various parts of England, and some of them undoubtedly grew an extremely fine-coloured tobacco. He was told at the time that some of the tobacco grown by Mr. Faunce De Laune was pronounced to be of as fine a colour as anything sent into the market. There was no doubt whatever about that, and it was certain that we could grow magnificent tobacco crops in this country. One or two of the cultivators managed to obtain the services of persons who had been engaged in tobacco curing in America and elsewhere, and in fact every premiss on which he had founded his argument was substantiated. They grew the tobacco, and in large quantities, and of fine colour; it was made up in various forms, but the public would not have it. What there was lacking in it exactly nobody had been able to find out, but the essential oils were for some reason found to be deficient in degree or in particular flavour and volume. One might of course smoke tobacco and be at the same time distinctly aware that it was not good tobacco. Mr. Cornwallis was still trying to produce a satisfactory article, but it seemed there were certain ingredients arising either from soil or climate in England which prevented the production of a really satisfactory article. With regard to Indian tobacco, what they had seen so far went to show that if all the doubts which had been expressed as to producing it of really good quality were true, the reasons would be found in what Mr. Tripp had said. He had told them in the Deli area of some 500 square miles, extremely fine Sumatra tobacco was produced; but that only across a small river fine tobacco could not be grown. That showed the existence of some ingredients in soil or climate in the one district which were wanting in the other. If that was a fair argument, it followed that in most parts of India those necessary ingredients which produced the finest tobacco were lacking. Still, it was certainly news to him that a smokable and marketable Indian tobacco was not produced. He was under the impression that a considerable quantity of Indian cigars were consumed in England. Mr. Applin had told them that a good British cigar grown on British soil, and managed by British workpeople could be produced in this country. He did not suggest for a moment that the Indian grower might not improve his system of cultivation and possibly the quality of the article he turned out. In all kinds of agriculture there were things to be learned as time went on; but improvements came very slowly, for the reason that agriculture was founded upon the experience of centuries; and they would never get the farmer, the man who was farming for profit, to alter his system of cultivation which had resulted from his forefathers' experience for centuries, simply at the instance of the first amateur farmer who came along and advised him to change it. He would allow the amateur farmer to waste his own money, but until a successful result were produced he would do nothing. When some such result could be produced in India a better state of things would arise. The agricultural chemists' assistance would be valuable, and perhaps after they had had a little time to investigate and consider the matter they would be able to suggest to to the Madras Government how better results might be produced. The meeting would join him in thanking Mr. Tripp for his valuable paper. It was by the means he suggested, carried out by Englishmen, that we might hope to spread knowledge on this subject, of which Englishmen might be able to take advantage in various parts of the world throughout the British Empire.

Mr. W. S. Seton-Karr writes:—I had no wish unduly to prolong the discussion of Thursday on Mr. Tripp's interesting paper, but I should like to add something about the cultivation of the tobacco plant in those districts of Bengal with which I was practically acquainted. Mr. Tripp spoke of India generally, but he compared the growth and manufacture of tobacco there with the cultivation of the plant in Sumatra, especially in connection with the want of skill and energy shown by the Indian cultivator. He said too, I think, that one important element or difficulty in India arose from the labour question. Now, in Central and Lower Bengal this question can hardly arise, or at least it is comparatively unimportant. Tobacco in that part of India is cultivated, in small patches, by the substantial, well-to-do tenant-proprietor or ryot, with certain well known interests in his few acres of land. He cultivates tobacco just as he does other higher kinds of produce, such as sugarcane, jute, oilseeds, the better kinds of pulse, and *pan*, and the betel nut. Tobacco is generally grown by him in small plots, near his homestead or in his garden, and it is a paying crop to the ryot who can afford to give the requisite care and attention to the subject. He cultivates it himself because it suits him and he has a good market for it; the question of hired labour rarely, if ever, occurs at all. It is quite true that tobacco cannot be grown in Bengal in large continuous tracts or in extensive gardens as, by the excellent photograph shown us, it can be grown in Sumatra; and I quite admit that nowhere in Bengal does the plant ever grow to the height of the Sumatra plant. But it does attain to the respectable height of a couple of feet, and I do not think that much fault is to be found with the method of cultivation, or that higher results could be produced by what is called "skilled processes." But, in the drying of the leaf and the manufacture of the article there is, no doubt, a good deal of room for improvement; and if any English capitalist should think of spending money on any such enterprise, it is in this particular direction that he might look for remuneration and success. As regards mere cultivation, whether of the ordinary rice crop, or the common kinds of pulse, or oats, or mustard, as well as the more expensive and remunerative crops, I may add that Englishmen who have proceeded to India impressed with the notion that the cultivator is ignorant of the rudiments of his own business, have very soon found out that they have a good deal to learn from him. I agree with the native gentleman who spoke from personal knowledge of Trichinopoly and the South of India, that, with his simple plough and his apparently primitive methods of agriculture, the ryot often shows clean farming and admirable results. The tobacco grown in Bengal proper is wholly consumed by the native population. At least, I never remember to have seen or heard of a cigar of Bengal tobacco bought or smoked by an Englishman.

Colonel R. G. WOODTHORPE, C.B., R.E., writes:—There is an immense tobacco plantation in the Southern Shan States, at a place called Ta Mongtse, on the Teng river—a few miles south-east of Moné. You look down from the hills above on a large flat valley, all of which is under tobacco cultivation, divided up into fields separated by high hedges representing various ownerships. The tobacco grown is exceedingly good, I am told by smokers; it is exceedingly nice to look at, but the smell of the smoke betrays it. The officers with the several expeditions smoked a good deal of it, and considered that it only required improved methods of manufacture to be a really good article.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 11, 1896; The DUKE OF ABERCORN, K.G., C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as member of the Society:—

Crowe, Sir Joseph Archer, K.C.M.G., C.B., 28, Avenue du Trocadero, Paris.
Pye, George Gard, 42, Brodrick-road, Upper Tooting, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Cooper, John Manning, 8–10, Great Pulteney-street, W.
Dobson, John R., Brompton, Northallerton, Yorks.
Dupré, August, Ph.D., F.R.S., Cliftonville, Sutton, Surrey.
King, Frederick William, Heybridge, Maldon, Essex, and Council Offices, Ilford, Essex.
McHardy, David, J.P., Cranford, Ruthrieston, Aberdeen.
Maxwell, Hon. Joseph Renner, M.A., B.C.L., 11, Wellington-street, Bathurst, Gambia, West Africa.
Montgomery-Moore, Alexander Willoughby, Holland-lodge, Eltham-road, Lee, S.E.
Murray, Thomas Blackwood, B.Sc., Heavyside, Biggar, N.B.
Thomson, Charles, Glenmount, Tierney-road, Streatham-hill, S.W., and South Wharf, Rotherhithe, S.E.

The CHAIRMAN, in introducing Professor Haddon, said he was not an Irishman, but he had lived for fifteen years in Ireland, being Professor of Zoology in Dublin, and was attached to the Science and Art Department in that city. He was also appointed naturalist to the Royal Dublin Society Fishery Survey of the west coast of Ireland, and was therefore well acquainted with everything related to the subject on which he was going to speak.

The paper read was—

PEASANT LIFE AND INDUSTRIES IN IRELAND.

BY PROF. A. C. HADDON.

The object of the present paper is to present a visual conception of the mode of life and the domestic industries of the peasants of the West and North of Ireland. I make no pretence to give a scientific account of economic conditions nor any solution of industrial problems.

I may say that I am not a political economist or politician, but simply a naturalist who has travelled somewhat in the West of Ireland, and I think it is always well to get a clear conception of the actual condition of the places we visit. I want you to see the peasant at home, and we will begin with a few lantern slides of the people themselves. The first is that of an Irishman as he does *not* exist in Ireland. The next one shows the Irishman as he is found in the Aran Islands in Galway. They are an extremely pleasing people, below the average height, which is 5 ft. 8½in. by nearly 4 in. They are rather slightly built, but have pleasant open countenances; and what strikes an Englishmen is the fairness of the complexion. One has the idea that an Irishman ought to be dark, but in the West there are a large number with brown hair, as these Aran islanders have, and the majority have grey or blue eyes, like most of the Irish. These people are very kindly and friendly, fearless, independent, and manly, and they used to be extremely honest, so much so, that if you lost a purse you would always find it the next Sunday or saint's day on the altar of the chapel. There was scarcely any crime, and if anyone was convicted of a crime the magistrate told him to go to jail, and he went off at his own expense a long way to Galway, and gave himself up. The character of the people has changed to some extent during the last forty or fifty years owing to external influences. They wear home-spun flannel, white or grey and cow-hide sandals or "pamtooties." Boots are now coming into use, but they are not so good in these rocky islands as the sandals. In many parts of Ireland men wear boots and the women go barefoot, but in the Aran Islands, owing to the large amount of bare rock, women are obliged to wear sandals or boots.

The next slide shows a typical Aran islander in a spotted waistcoat, grey or blue, with white flannel sleeves, and a Tam o' Shanter cap. Like many in the West of Ireland these people are almost too well clothed; they wear heavy woollen clothes, which are always ample, though often somewhat ragged.

Here is another group of Aran islanders from the Middle Island (Irishmain). I told the women they should have a copy of their photographs if they would sit for me, but owing to the superstition there, it is thought unlucky to give their names; rather than give me their names they preferred to go without their photographs. The same thing sometimes occurs with the men, and they prefer not to be photographed at all.

Now we come to another island, Inishbofin, where we find a darker and more burly people, who are also of a more truculent disposition. They are suspicious of strangers, and there is not too much good feeling between them and the people on the mainland, each giving the other rather a bad character.

The next photographs were taken in con nection with the ethnographical survey o Ireland. There is a committee in Dublin fo studying the ethnography of Ireland, and Dr Browne has made valuable reports* on th Aran islands, Inishbofin, and Co. Mayo These reports give the first accurate accoun we have of the people, of their height, size an shape of their heads, colour of hair and eyes and various vital statistics, also the economi conditions, their industries, rental mode of lif folklore, and so on.

We find the people very courteous an friendly in the real country parts, where the have not been too unfortunate. They ar hospitable; always glad to see you and to giv you a drink of milk.

This is the fishing village of Teelin, a fishin village in Donegal. The roofs are of thatch and, owing to the strong winds, the pitch i not high, and the thatch has to be kept on b means of straw bands, which are fastened t the walls.

The next slide shows the village of Bally hoorisky in "Fanad between the waters," Co Donegal, which is very characteristic in man respects; it is not easy to see which are house and which are rocks. The latter are ver common in the West of Ireland, and give th country a peculiarly desolate appearance.

The houses are small, because they a made of stone. There are very few trees the West of Ireland, and throughout large area there are none whatever. There is a story North Clare of a man who was a sceptic; h spiritual adviser was discussing the point wi him, the miracles were no stumbling block, b he could not understand how it was said th Zacchæus climbed up into a tree; for he sa there never was a tree big enough to hold man. It is very surprising to go for long di tances and to see no trees at all; they have build their houses mainly of drift wood. some places, in Achill for instance, the windo are stopped up, the doors are closed, and th smoke finds its way through the thatch, whi once a year is used as manure. This of cour does not make the house more pleasant to li in.

The next slide represents a typical house the island of Bofin. The peculiarity of th ouse is that the chimney is in the gable. n most houses there is a chimney which equently is made of boards, but sometimes iere is only a hole in the roof instead of a uilt-up chimney. The houses have very small indows ; there is either a single bedroom or vo bedrooms, one at each end, and a kitchen. n the kitchen there is a large fire-place. In iany parts of the West of Ireland the cattle are rought into the kitchen ; the pigs have a orner for themselves. The Aran pig is very leanly in his personal habits.

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* "The Ethnography of the Aran Islands, Co. Galwa A. C. Haddon and C. R. Browne, "Proc. Roy. Irish Aca (3) II., 1893, p. 768; "The Ethnography of Inishbofin a Inishshark, Co. Galway," C. R. Browne, *ibid* III., 18 p. 317; "The Ethnography of the Mullet, Inishkea Islar and Portacloy, Co. Mayo," C. R. Browne, *ibid* III., 1895, 587.

The next slide is of the fishing village of illeany in Aran. It gives you a typical view, nd you notice that the gables of the houses are tepped in a peculiar way. Here you notice ie Irish pig with his peculiar high back. he breed of the Irish pig has now been nproved. The old kind of pig had a high ack, and was not a particularly fleshy nimal. Where stone is not abundant—and iat is very rare—houses may sometimes be uilt of peat. This slide shows a peat or irf house in County Derry, but this is not a ommon type of house. We have all heard of ie mud cabins of Ireland, and this slide re-resents one in Malone, County Antrim.

We are now coming to the eastern part of reland, and you see that the houses have a ifferent kind of thatch. Lastly, we may take ie village of Waringstown, in County Down, s a type of an industrial village. This is hand-loom weavers' village. Owing to the idustrial habits of the people they can, appa-ently, make more money and afford to have etter kind of houses. It is refreshing now nd again to come from the poor West to the omparatively richer East, and to see that nder favourable conditions the people can ve comfortably.

The next slide represents the interior of a irm kitchen in North Antrim. Beyond the itchen you see the bedroom. In Ulster and ie East of Ireland, the people are well to do, nd have better furniture than they have in the Vest and in Donegal. Here is the large fire-lace which is so characteristic of the Irish itchens. From the beam we have the griddle, nd above it you see the instrument for making raw ropes. By the wall is the settle bed. This articular floor is flagged, but in the great iajority of houses in the West the floor of the itchen is earth, or clay as they call it. As general rule, the bedrooms are boarded.

So much then for the houses in which most the Irish peasants live.

The work of women is illustrated by the domestic industries of grinding corn with querns, and washing clothes by beating with a beetle. The very laborious work of grinding corn by a quern has almost entirely been superseded by flour mills ; this photograph, taken by Dr. Browne, is believed to be the only one showing the process in Ireland. The operation of carding wool and of spinning it into thread, in the Island of Inishbofin, is shown by several slides, of women spinning at their wheels in Counties Antrim, Donegal, and Leitrim, as well as in Aranmore and Connemara in County Galway, which also demonstrated the various kinds of spinning-wheel now in use. The small treadle spinning-wheel, which was characteristic of England and Scotland, was distributed over Leinster as it still is over Ulster ; whereas in the west of Connaught there is a simpler implement, the fly-wheel of which is turned by the hand. In some parts of Ireland lace-making continues to be practised. The slide now on the screen shows an old lady of Newtownards, County Down, "sprigging" or "flowering" on cambric outside her cottage. Knitting is encouraged by philanthropic societies and individuals in the North and West, and it is very encouraging to see peasant girls busily knitting away by the road-side or at the cabin door.

The work of the men consists chiefly of agriculture, turf-cutting, fishing, and kelp-burning. There is very little good soil in the West, and in the Aran Islands, some of the soil has actually had to be made by bringing up sand and seaweed from the shore and strewing them on the bare rock. The views of Aran "fields" now thrown on the screen illustrate the wonderful bare sheets of naked rock on these islands. The great bulk of the cultivation in the West is by spade labour, and the narrow-bladed, long-handled Irish spade, or "loy," is very different from the English spade, as the accompanying slides show. Hay is cut for fodder, and as this photograph shows, even whins (gorse or furze) is beaten with a mallet, and then it is used as fodder for horses ; the principal crops are barley, oats and rye, and, of course, the ubiquitous potato. The women help in the lighter portions of field labour.

The great extent of bog-land enables the people on the mainland to get plenty of fuel ; the women assist in the spreading and stacking of the turfs ; these processes are illustrated by photographs of an Antrim bog.

Fishing is essentially men's work, and there is an abundance of fish off the coasts, but the small light curraghs are not suited for the development of this industry, although they are a useful craft in many ways. The Congested Districts Board of Ireland is now developing the highly important industry of fish-curing. [Photographs of various kinds of curragh were shown on the screen, and the way in which they are beached and how they are made.]

The gathering and burning of kelp is a profitable means of livelihood along the north and west coasts, and engages both sexes. [The process of manufacture was illustrated and briefly described.]

[The flax industry of the North was touched upon, and lastly photographs were shown of a less legitimate method of earning a living by the manufacture of poteen, or illicit whisky.]

The commercial prosperity of a country depends upon facility of transport; the value of a ready and cheap means for the conveyance of products cannot be over-estimated. Let us see how Ireland has fared in this respect. In many parts of the West there were no true roads till comparatively quite recently, and consequently no wheeled vehicles. One of the blessings wrested from the awful famine period was the building of roads, and during later famines the same wise policy has been continued. In Ireland we have a more complete series of stages illustrating the evolution of the means of transport than occurs anywhere else in the world. We find everywhere what is known to anthropologists as "the human beast of burden." In the remote part of the country pack-animals may still be seen. In the glens of Antrim the very primitive slide car, sometimes, even with straw harness, continues to be employed. Here also are various kinds of block-wheel cars, stranded relics of vehicles elsewhere extinct. Lastly we have the convenient Irish jaunting car which was evolved at the beginning of this century. The long cars, which carry residents and tourists to remote districts, are the descendants of the cars introduced by Bianconi in 1815. This philanthropic and wise Milanese did immeasurable good in opening up the country and thereby developing local resources. We may reasonably hope that the light railways of the present day, or other means of conveyance, such as auto-cars, will give a yet greater impetus to nascent local industries, and thus materially assist towards improving the condition of our charming fellow-countrymen.

The following is a classified list of the slides exhibited, many of which were made by Mr. Welch, of Belfast, who is assisting the committee for the ethnographical survey of Ireland by taking photographs illustrating the various customs and implements of Ireland.

People.—Various groups of Irish peasants from the Aran Islands, Co. Galway; Inishbofin, Co. Galway.

Habitations.—Teelin, a Donegal fishing village; Ballyhoorisky, a fishing-farming village ("Fanad between the waters"); a cabin in Inishbofin; Killeany village, Aranmore; a cabin built of turf in Co. Derry; mud cabin, Malone, Co. Antrim; Waringstown, Co. Down, a hand-loom weavers' village; a mountain-farm kitchen, North Antrim.

Women's Work.—A woman grinding corn with a quern, Inishbofin; girl washing clothes in a lough with a beetle, Inishbofin; spinning wool—(1) Fair Head, Co. Antrim; (2) Rosapenna, Donegal; (3) Co. Leitrim; carding wool, Aran Islands; spinning wool, Aranmore; ditto, Connemara; sprigging or flowering on cambric, Newtownards, Co. Down.

Men's Work.—Fields in Aranmore (two slides); an Irish spade; ditto, Inishbofin girls setting seed potatoes, Glenshesk, Co. Antrim; knockin' whins for horses' food, Glenshesk; a Tonduff (Co. Donegal) fisherman baiting night-lines; a curragh, Aranmore carrying a curragh, Aranmore (two slides) beached curraghs (two slides); an Aran stone anchor; the building of a curragh (two slides) a Sheep Haven curragh; an ancient form o curragh still used on the Boyne, at Slane, Co Meath; cutting, spreading, and ricking turf Co. Antrim (two slides); drying and stacking kelp, Ballycastle, Co. Antrim; ditto, Aranmore; lint-wheels, or flax-bruisers, Rathmullan Co. Donegal; old flax scutch mill, Cushendall Co. Antrim; hand-loom weaver at work at an old linen damask loom, Co. Antrim; poteen still on a Western island; the risks of illici distillation (three slides).

Transport.—Woman carrying turf, Inishbofin; panniers on a donkey, Co. Leitrim slide car for corn, Glenshesk, Co. Antrim ditto, for turf, Co. Antrim; ditto, with straw harness, Glendun, Co. Antrim; block-whee car, with revolving axle, Cushendall, Co. Antrim; ditto, Glenshesk, Co. Antrim; ditto, with fixed axle, Co. Antrim; spoke-wheel car Glencoe, Co. Antrim; an Irish outside- o jaunting-car; the Bianconi cars; a Connemar long-car.

DISCUSSION.

The **CHAIRMAN** in proposing a vote of thanks to Professor Haddon said he could not help referring o the masterly way in which he had led from one ubject to another, beginning in the first instance with he usual lawful usages of the people on the West Coast of Ireland until he came to the final risis of the illicit spirit distillery, when the onstabulary came upon those who were breakng the law. There was no more law-abiding eople than the Irish when left to themselves, ut at the same time no one more enjoyed little occasional breaking of the law if hey could do it unmolested. Perhaps the English eople might have some little sympathy with the rish in that respect. The photographs which had een exhibited were remarkably good; they were ealities and spoke for themselves. He could guaranee that the Professor had not been drawing upon is imagination; but everything he had said as perfectly accurate. In fact, he was himself cquainted with the various districts in Donegal of hich Professor Haddon had given representations, howing the extraordinary quiet and unsophisticated anner in which the good people of the west coast conucted their business. It must not be supposed that e cottages and arable lands in the Island of Aran ere typical of the whole of Ireland, because such as not the case. They could show as good farm uildings and cottages in some parts as were to be und in any part of England. The Professor toight had been illustrating the manners and habits f the poor people in the north-west and north-east oasts, and had referred in a simple way to the rious industries pursued in these parts, and he entioned, amongst others, the "sprigging" which as largely carried on in cottages in the north and also the south of Ireland. It consisted in working owers on cambric, and he ventured to suggest that y ladies who wanted fine work of that character one, if they would apply to the proper people in e north of Ireland, could procure it at much eaper rates than in England. He might also ention some other industries to which Professor addon had not alluded, which were connected with e country generally. On the 17th and 18th of this onth a large industrial exhibition was to be held in ondonderry-house, Park-lane, for the benefit of varius Irish industries, which it would be seen, by the lvertisements, was receiving the support of all ctions and classes of those who had the inrests and prosperity of Ireland at heart. He oped ladies and gentlemen would attend it in large umbers, take full purses with them, and bring them ck empty. The paper had interested him very eeply, and he was sure a hearty vote of thanks ould be accorded.

Professor **HADDON**, in reply, said he must apoloze to any persons who had come expecting to hear an account of the economic industries of Ireland. He had warned them at the outset that he was only a naturalist, not an economist; and, as had been remarked by the Chairman, he had said nothing about some of the chief industries. Many of the Irish farmers were very well to do, especially in the grazing and horse-breeding districts. The horse-show of the Royal Dublin Society was the finest horse-market in Europe. There were other industries, such as the flax, and linen, and cambric manufactures, which were locally developed, and were a credit to the country. But he could not cover the whole ground, and had only attempted to give a peep at the difficulties which the people laboured under who had the misfortune to live in the extreme West and North-West of Ireland. He should like to urge every one to visit Ireland as often as possible, for it was an extremely interesting country, and contained much to be seen which people went to distant countries to discover. Ireland was backward in many ways, but backwardness did not mean barbarism; it simply meant that they had not got the complications of civilised society. The people themselves were friendly, hearty, and, as a rule, unsophisticated. On a holiday, one wanted to get away from civilisation and return to more primitive conditions, and these were to be found as much in Ireland as in the more remote parts of the Continent.

Miscellaneous.

ART AND SCIENCE IN AUSTRALIA.

There are art galleries at Balmoral and Adelaide, and an effort is being made to establish one in Brisbane; but these, for a considerable time to come, can possess only a limited educational value. In Sydney, the existence of a public art gallery dates from 1880, when the New South Wales Government took over a collection of pictures and sculptures formed by the New South Wales Academy of Art, which, with the numerous additions subsequently made, has an estimated value of £100,000. It contains numerous examples by Australian artists, and the collection of water-colour drawings is said to be one of the finest out of England. In the same city is an Art Society, established in 1880, which conducts antique, life, and painting classes, in each of which annual scholarships are awarded. There is also an annual exhibition of between 300 and 400 works of art, executed by its members. An offshoot of the association has been established under the name of the Society of Artists, within the last few months, and numbers nearly 150 members. There is also a Brush Club, likewise several provincial art societies.

Science is represented in the colony by the Royal Society of New South Wales, which originated in 1821 as the Philosophical Society of Australasia, the present name being adopted, by Royal sanction, in 1856. The objects of the society are to receive original papers on science, art, literature, and philosophy; also on subjects tending to develop the resources of the colony, and to illustrate its natural history and productions. It has a valuable library, and also publishes an annual volume of transactions. The Linnean Society of New South Wales was established, mainly by the efforts of the late Sir William Macleay, a devoted naturalist, in 1875, and has numbered among its members many of the leading scientific men, including the late Dr. George Bennett, in Australasia. Its objects are the study and cultivation of the science of natural history in all its branches. The papers are frequently of considerable scientific interest, the more important being published in the annual volume of transactions.

The Royal Geographical Association, established in 1883, has branches in Victoria, South Australia, and Queensland. Its objects include the advancement of geographical science, the completion of Australasian exploration, and the study of commercial geography, with a view to promote the commercial progress of Australasia. The head-quarters of the Australasian Association for the Advancement of Science, based on the lines of the British Association, are in Sydney. The Association was established in 1888, its object being to give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the Australasian colonies and in other countries; and to obtain more general attention to the objects of science and the removal of any disadvantages which may impede its progress. The meetings of the Association are held alternately in the various colonies.

Among other scientific Associations in Sydney are the New South Wales Zoological Society, branches of the British Astronomical and British Medical Associations, Australian Economical Association, Pharmaceutical Society, Engineering Association, Insurance Institute, Institute of Architects, Institute of Bankers, Electric Club, Institute of Surveyors, &c.

Correspondence.

THE REPORT OF THE ROYAL COMMISSION ON SECONDARY EDUCATION.

The Rev. J. O. Bevan, M.A., President of the Private Schools' Association, 1894-1895, writes:—I am sorry to trouble you again, but may I ask your indulgence whilst I say a few words in response to Mr. Macan's rejoinder? It was evident that my letter of the 28th ult. had been inserted in an abbreviated form. Hence, the full bearing of my remarks was not everywhere apparent. Conscious that your *Journal* cannot be made the medium of a lengthy correspondence, I will not now attempt to reply
seriatim to Mr. Macan's further observations. H
paper and my letter are equally before your reader
and they can judge for themselves as to the force
my criticisms. With the consciousness that referen
might be immediately made to the text of his addres
it was hardly likely that I should attempt to mi
quote his words. Mr. Macan says, "I am n
aware that he gives me notice when . . . . he mak
statements without foundation as regards public auth
rities." I have yet to learn, however, even supposing
have made such unfounded statements, that Mr. Mac
has been furnished with a general brief in defence
public bodies. But, if at any time, I had attack
him personally, or threatened to expose an associ
tion of which he was the head, I should certain
have communicated with him; and putting aside,
this case, any question of right, I repeat that
should have esteemed it as an act of courtesy if
had made me aware beforehand of the atta
contained in his paper of February 21st. T
Private Schools' Association has set itself
discharge an important duty, viz., the defen
of the liberties of all efficient private schoo
Allowing, for the sake of argument, that t
involves elements of peculiar difficulty, would
not follow that the Association deserves a larg
sympathy and more effectual help? I am n
concerned to answer the particular charg
brought against us in such a random and heedl
manner. Our aim is declared before the world. T
only guarantee the public can possibly have of t
honesty and good faith of any body of the kind is t
character of its responsible heads. Of the charac
and position of our officers and council it is n
necessary for me to say anything. Suffice it
remark that we can afford to smile at Mr. Maca
insinuations. As an Association, we are content
be placed, in his estimation, on a level with
Oxford Conference of 1893; and, as an individual
am ready to stand by the side of such men as Sir
Temple and Sir E. Clarke. Mr. Macan says:—
shall be happy to discuss these matters with
Bevan upon any platform and anywhere." I tr
I have too much self-respect to allow myself to acc
this offer. I again declare that the methods he ado
and the language he employs are unworthy of the t
educationalist, and tend only to embitter a c
troversy which all real friends of the young wo
seek to allay. I am perfectly prepared to de
this and kindred subjects, at all times, before
assembly of fair-minded gentlemen; but I have
taste for personal controversy, and I should certa
not have addressed you at all, unless it were
answer an unfair and unprovoked attack.

General Notes.

Indian Irrigation Department.—In the H
of Commons on Tuesday, Sir Seymour King as

he Secretary of State for India, whether his attention ;as been called to observations made in a paper read ·y Sir J. B. Lyall, lately Lieutenant-Governor of the ʾunjab, at the Society of Arts on 13th February, on he high scientific and economic value of the work erformed by the officers of the Indian Irrigation)epartment, its responsible and risky nature, and the xceptional hardships involved in living in insalubrious ut-stations where bread and decent food are not rocurable, the unpopularity of the service, and the iscontent among the executive and assistant en-ineers in it: Whether, when Lieutenant-Governor ˙the Punjab, with Colonel Ottley as Chief Engineer, ir J. B. Lyall proposed to the Government of India ;at, as partial compensation to these officers for the :ceptional conditions above summarised, superior ıy, in the form of out-station allowances, should be anted to these engineers: Whether the proposal as approved by the Indian Government: And, hether any information of the proposal, and the ounds of disapproval, has been received at the dia Office; and, if not, whether he will call for a eport on the subject from the Viceregal Govern-ent. Lord George Hamilton replied as follows:—ıe statements in Sir J. B. Lyall's interesting paper erred to by the hon. member have been brought to notice. It is the case that a recommendation was de by Sir J. B. Lyall, when Lieutenant-Governor the Punjab, to the Government of India for the nt of "jungle or out-station allowances" to cer-n engineers of the Irrigation Department. This ommendation was not, however, accepted by the vernment of India, on the ground that the circum-nces of the officers in question did not differ widely, t all, from those of officers of the Public Works l other departments in other parts of India who e stationed in outlying or solitary districts. I see reason for interfering with the discretion of the vernment of India in this matter.

ECEIPTS OF PARIS THEATRES IN 1895.—A ement has recently been issued by the French orities showing the gross receipts of the principal tres and places of amusement in Paris during the 1895, to which is added a return showing the unts realised at the various *cafés concerts*. The eral total amounts to the sum of £1,186,400, as pared with £1,170,300 in 1894—an increase of ,100. Taking the amounts received at each blishment, it will be found that the Opera, as l, headed the list in 1895 with a revenue of 6,000 (£125,000 in 1894). Then comes the édie Française, with £83,000, and the Opera ique, with £57,800; the Varietés realised ,000; the Vaudeville, £46,000; the Gymnase, ,700; the Palais Royal, £27,700; the Porte St. tin, £38,000; the Renaissance, £34,600. The veau Cirque realised £28,500 in receipts, while Cirque d'Hiver only yielded £16,600. On the of *cafés concerts*, the Folies Bergères heads the with receipts amounting to £43,400; Olympia comes next with £25,500. Then follow the Casino de Paris, with £23,400; La Scala, with £22,300; the Moulin Rouge, with £21,200; and the Eldorado, with £21,000.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 18.—"Bahamas Sisal Industry." By DR. D. MORRIS, C.M.G., M.A. GENERAL SIR HENRY W. NORMAN, G.C.B., G.C.M.G., will preside.

MARCH 25.—"Our Food Supply, as affected by the Farming of the Future." By PROF. JAMES LONG.

Papers for meetings after Easter:—

"Early English Organ Writers." By BURNHAM HORNER.

"The Perfected Photochromoscope and its Colour Photographs." By F. E. IVES.

"Fruit Drying or Evaporation." By EDWARD W. BADGER.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Dairy Produce." By GEORGE BARHAM.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock:—

MARCH 19, at 8.30.—"The Great Landslip at Gohna, in Gurhwal, and the Measures Adopted to Prevent Serious Loss of Life." By J. H. GLASS, C.I.E., Chief Engineer, Dept. Public Works, Bengal. SIR CHARLES H. T. CROSTHWAITE, K.C.S.I., Member of the Council of India, and late Lieutenant - Governor of the North - Western Provinces and Oudh, will preside.

MARCH 26, at 8.30.—"Kashmir: its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E. The EARL OF DUNMORE will preside.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of April 23, and May 14 will be held at the Society of Arts; those of March 19, and March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

The meeting announced for April 14th will not be held.

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

The meetings announced for March 17th and April 21st will not be held, and Mr. H. Vogel's paper on "The Maories," and Captain Pasfield Oliver's paper on "Madagascar," announced for those dates, are unavoidably postponed.

MARCH 24.—"The Colonies and the Supply of Dairy Produce and Products of Petite Culture." By CHARLES R. VALENTINE. SIR WESTBY B. PERCEVAL, K.C.M.G., will preside.

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

H. GRAHAM HARRIS'S Cantor Lectures on "Refrigeration," announced for delivery on March 9, 16, and 24, are unavoidably postponed.

HENRY A. MIERS, M A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 16...Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Charles Dyall, "The Technical Characteristics of Modern Pictorial Art."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Arthur C. Pain, "The Light Railway Bill, 1896."

Geographical, University of London, Burlington-gardens, W., 4½ p.m. Mr. John Myres, "The Maps used by Herodotus."

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. L. Viollier and Lawrence Harvey, "St. Pierre-ès-Liens: the Ancient Cathedral of Geneva."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "The Relations of Mind and Body."

East India Association, Westminster Town Hall. S.W., 3 p.m. Mr. A. K. Connell, "The Financial Condition of India and the Closing of the Mints."

TUESDAY, MARCH 17...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Covering of Plants and Animals: its Structure a Functions." (Lecture X.)

Civil Engineers, 25, Great George-street, S.W., 8 p.

Statistical, Royal United Service Institution, Whi hall, S.W., 5 p.m. Mr. John Watson, "Reformat and Industrial Schools" (Howard Medal Pr Essay).

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p Photo-Mechanical Meeting. Captain Collard (i) "Screens for Process Work;" (ii) "A Note Photogravure."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Li Colonel C. T. Bingham, "A Contribution to Knowledge of the Hymenopterous Fauna Ceylon." 2. Mr. Edward T. Brown, "Bri Hydroids and Medusæ." 3. Mr. A. Smith Wo ward, "Some Extinct Fishes of the Teleos Family *Gonorhynchidæ.*"

Colonial Institute, Northumberland-avenue, W 4½ p.m. Dr. Charles Chewings, "Geolog Notes on the Coolgardie Goldfields."

WEDNESDAY, MARCH 18...SOCIETY OF ARTS, John-st Adelphi, W.C., 8 p.m. Dr. D. Morris, " Bahama Sisal Industry."

Meteorological, 25, Great George-street, S 7½ p.m. Mr. Frederic Gaster, "Weather F casts and Storm Warnings: how they are prep and made known."

Microscopical, 20, Hanover-square, W., 8 Dr. A. C. Stokes, "Some American Rotifera."

Photographic Club, Anderton's Hotel, Fleet-st E.C., 8 p.m. Mr. Snowden Ward, "The Photography."

Archæological Association, 32, Sackville-street, 8 p.m.

THURSDAY, MARCH 19...SOCIETY OF ARTS (at Imperial Institute, South Kensington, S.W p.m. (Indian Section.) Mr. J. H. Glass, " Great Landslip at Gohna, in Gurhwal, an Measures adopted to prevent serious Loss of

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. D Hapf, "The Structure of the Female Flowe Fruit of Sararanga, Hensl (Pandanaceæ). Mr. G. A. West, "Two little-known Opi lyphous Snakes."

Chemical, Burlington-house, W., 8 p.m. 1. M J. H. Fenton, "The Constitution of a Organic Acid." 2. Mr. A. E. Tutton, Volume and Optical Relationships of the clinic Series of Double Sulphates R_2M (S H_2O."

Society for the Encouragement of Fine A Conduit-street, W., 8 p.m. Mr. James C "Constable: with Illustrations by the Paint

Royal Institution, Albemarle-street, W., 3 p.m William Barry, "Masters of Modern Tho (Lecture III.—Goethe.)

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8 p.

FRIDAY, MARCH 20...Royal Institution, Albemarle W., 5 p.m. Weekly Meeting, 9 p.m. F Fraser, "Immunisation against Serpents' and the Treatment of Snake-bite with Anti

Philological, University College, W.C., 8 p.n

Queckett Microscopical Club, 20, Hanover- W.C., 8 p.m.

SATURDAY, MARCH 21...Royal Institution, Albemarle W., 3 p.m. Lord Rayleigh, "Light." ture V.)

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FRIDAY, MARCH 20, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

roceedings of the Society.

OREIGN & COLONIAL SECTION.

Tuesday evening, February 18, 1896: W. . PREECE, C.B., F.R.S., Vice-President of e Society, in the chair.

The paper read was—

HE DEVELOPMENT OF ELECTRICAL TRACTION APPARATUS IN THE UNITED STATES.

By H. F. Parshall.

In this paper I propose to discuss and ustrate the more important details of the achinery especially developed for use in ectrical traction.

At the commencement of my experience, out six months was taken to construct forty eet car motors. At the present day, in the me works, there are constructed regularly o street car motors per week, and, in some ses of extreme demand, as many as 500 ve been constructed in the same length of ne.

The difficulties experienced with the appara- s, as first designed were largely confined to motor and motor regulator, this latter being w commonly called the controller. After se had been brought into a better state of rfection, refinements were introduced in Power Station and in the switching ap- ances. This being the order of develop- nt, it will also be taken as the order for cussion.

The tramway motors first constructed in the ited States were but little suited for the rk of electrical traction. Engineers but le understood the great strain, both mechan- l and electrical, to which this machinery uld be subjected. In general, the motors re designed on much the same lines as ntral Station dynamos and stationary motors had previously been. The speed and the torque at different speeds of the motors, in general, did not agree with the speed and resistance of the car at different speeds. Special attention was paid to the efficiency at full load, but, inasmuch as the mean working point was much less than the full load of the motor, efficient results were not obtained until power measurements as to the average work required for the propulsion of a car were made, and the motor so designed that the efficiency was towards a maximum at the average working point of the motor.

Another point that was not clearly recognised related to the torque per ampere best suited to such a motor. In starting the car, the torque per ampere should be a maximum. As the car becomes accelerated, the torque per ampere should be less and should fall off according to the maximum speed to be attained. In the first motors the torque per ampere, owing to the proportions of the motor, was approximately constant, so that an excessive starting current was required, this being so great that, frequently, there was great heating of the windings, and the durability of the motor was greatly impaired. At the present day, in well designed street car motors, the effort at the car wheel is about forty pounds per ampere in the armature, and, when running at full speed, from twenty to twenty-five pounds. In thus varying the range of torque per ampere the efficiency of the motor has been increased, and, likewise, the durability of the parts in which the electrical losses occur.

The mechanical improvements found necessary to make were numerous and important. The diameter of the shaft had to be increased so that the factor of strength was some six times greater than in ordinary station motors and dynamos; the bearings had to be increased in length and diameter; and the face of the gear had to be increased, and also the pitch. The fine pitch that had previously been found satisfactory in machine construction was found to be altogether unsuited for tramway motors.

Improvements were also made in the method of holding the armature conductors, since it was found that the conductors, when held in the ordinary way, would shift in respect to each other, and so injure the insulation as to impair the durability of the armature.

In order to lessen the deterioration of the controlling mechanism, which was either a commutating switch or a rheostat, it was found necessary to design the motor so that the torque per ampere, at a given speed, coincided with the resistance of the car for a given acceleration and speed. Increasing the efficiency of the motor, that is, lessening the amount of current for which a given torque and acceleration is produced, greatly lessened the deterioration of the controlling apparatus, so that advancement in the design and efficiency of the motor was accompanied with a corresponding durability of the controlling apparatus.

The next more important step in this direction was the substitution of the multipolar motor and the dispensing with one set of gears. This was found practicable, when the manufacture of steel had advanced so that castings of high permeability, and of the complex form required for tramway motors, could be made. The earlier types of motors were made of forgings of simple shape, which were not of such form as could be made into multipolar motors. This last change was accompanied by numerous other mechanical improvements. The gears, shaft and bearings were again increased in size. The method of lubrication was improved, the gears being placed in an oil-tight box, so that their durability was increased some three or four times. A steel gear will now wear for three years and a pinion nine months, in an equipment making 100 miles a day. The pinions usually have 13 to 16 teeth and the gear from 60 to 70. The pitch commonly used is that known, in the United States, as the No. 3 pitch, *i.e.*, the diameter of the gear divided into the number of teeth = 3. By making the shaft more rigid, and by studying the form and clearance of the teeth, a gear has now been produced that makes comparatively little noise.

Another improvement relates to the method of suspending the motor in the so-called "nose-suspension" manner, in which the motor is carried by a lug and cross bar. The top axle lining lasts about six months, and the bottom axle lining about twelve months. *With the side bar suspension*, in which the motor is suspended in a line vertically underneath its centre of gravity, the axle linings last twice as long.

Great mechanical improvements have also been made in the construction of the commutator, which is subjected to hard usage, owing to the necessity of carbon brushes (set at a very considerable pressure on account of the vibration of the motor). A well constructed commutator may now be expected to last two years.

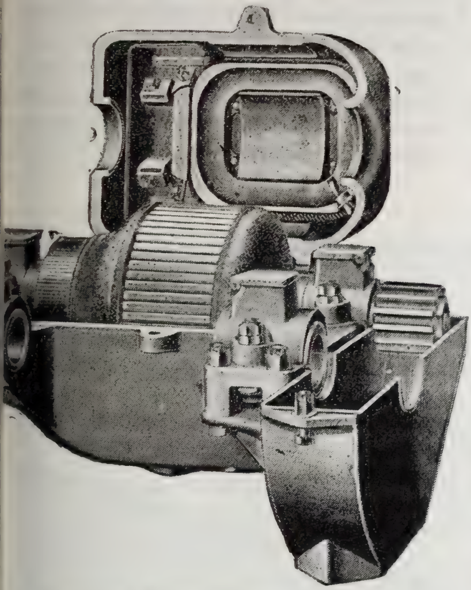
A further improvement has been to completely house the motor in a steel casing so that it is now entirely waterproof. The force with which water penetrates a tramway motor in a wet street is remarkable, since the join between the upper and lower halves of the motor have to be especially larded to keep the water from oozing through even when the surfaces are as perfectly milled and fitted together as possible. The electrical features of the motor have also received decided mechanical improvement. The armature coils are formed and interchangeable, and insulated first with asbestos, and, secondly with mica and tape, so that it will withstand a very high temperature. The method of securing the armature coils has also formed the subject o study and improvement. The coils are now held upon a conical surface, and securely clamped by a nut so that any shifting is prevented.

Another improvement is in reference to th magnet coils, which are insulated with asbestos and made entirely waterproof. It would seem perhaps that this was unnecessary, considering that the motor itself was made waterproof, bu condensation of water frequently occurs in a encased motor, and renders it necessary fo good results that both the coils of the field an of the armature should be waterproof.

Another improvement that has been foun of great importance in practice is the diminution of the weight of the motor for a give power. This has been done by the use o steel, and by studying, particularly, th mechanical construction, and the nature of th work to be done. A motor nominally rated a 25 horse-power, complete with the gearing now weighs about 1,500 pounds. Such a moto cannot, of course, do 25 horse-power permanently, but it is rated on its capacity for doin this work for a limited period of time—generally two hours—this being a more sati factory manner of rating for electrical tractio With this diminution of weight it has bee found that the deterioration of tracks, truc and bearings, has been greatly lessene Great improvements have also been made the construction of trucks for tramway pu poses. The truck shown in the lantern sli and in the model is one of those very general used in the United States.

The motor that has heretofore been illu trated, and particularly discussed, is what known as the "standard tramway motor," *i.e* a motor capable of exerting 800 to 1,000 l horizontal effort on the car wheel, wh unning 10½ miles per hour and delivering 5 horse-power, when mounted on 33 in. wheels nd loaded to its rated capacity. It differs nly in the point of size from the larger motors

FIG. 1.



STANDARD STEEL TRAMWAY MOTOR.

ew shows top half opened, to exhibit Armature and Commutator. The top half of the Oil Tight-gear-case is also removed, to show Pinion.

at are used in what may be termed "light ilways," along which trains, weighing from to 100 tons, are moved at a speed of 15 to miles an hour, and, in some cases to 60 iles an hour.

In the standard motor the diameter of the car axle is $3\frac{3}{8}$ in., the pinion is seated with paper bore, the axle gear is of cast iron, and the gear reduction is 4·78 to 1. This motor is suited for all ordinary city tramways. It has been frequently wound for a higher speed and different output, but the consumption of energy in a given time is increased according to the increase of speed, that is: the consumption of energy per car mile in a given motor remains practically the same so long as the magnetic conditions remain constant. In high speed or suburban railway work, where heavy grades and heavy loads have to be met with and drawn from 20 to 30 miles an hour, a motor having a rated horizontal effort of 1,200 lbs when running 12 miles an hour and delivering 40 horse-power under the previously mentioned conditions is commonly used. For a still heavier class of work two or four motors are used per train, each giving 2,000 lbs horizontal effort when running 20 miles an hour and delivering approximately 120 horse-power under the previously mentioned conditions. Two such motors will operate three ordinary passenger cars at a speed of 30 to 40 miles an hour, and four of them operate six passenger cars. It is interesting to note that, in the design of these motors, the maximum rated horizontal effort is not varied by varying the number of turns on the armature so long as the weight of the copper and the magnetic flux remain the same. I give herewith a Table that shows the general results and traction co-efficients that have been obtained in the United States with the forms of equipment with which I am familiar.

TABLE OF HORIZONTAL EFFORTS AND TRACTION COEFFICIENTS.

OUTPUT AT FULL LOAD.						
urns per coil on armature	3	4	2	3	4	2
orizontal effort for equipment in lbs.	1,600	1,600	2,400	2,400	2,400	4,000
peed in miles per hour	10·5	10·5	17·5	12·0	9·5	10·5
otal horse-power of equipment	60	50	110	80	60	110
OUTPUT REQUIRED TO DRIVE LOADED TRAIN ON A LEVEL.						
orizontal effort for equipment in lbs.	220*	220*	450†	450†	450†	600
peed in miles per hour	26	23	28	20	18	18
otal horse-power of equipment	16	14	34	24	22	29

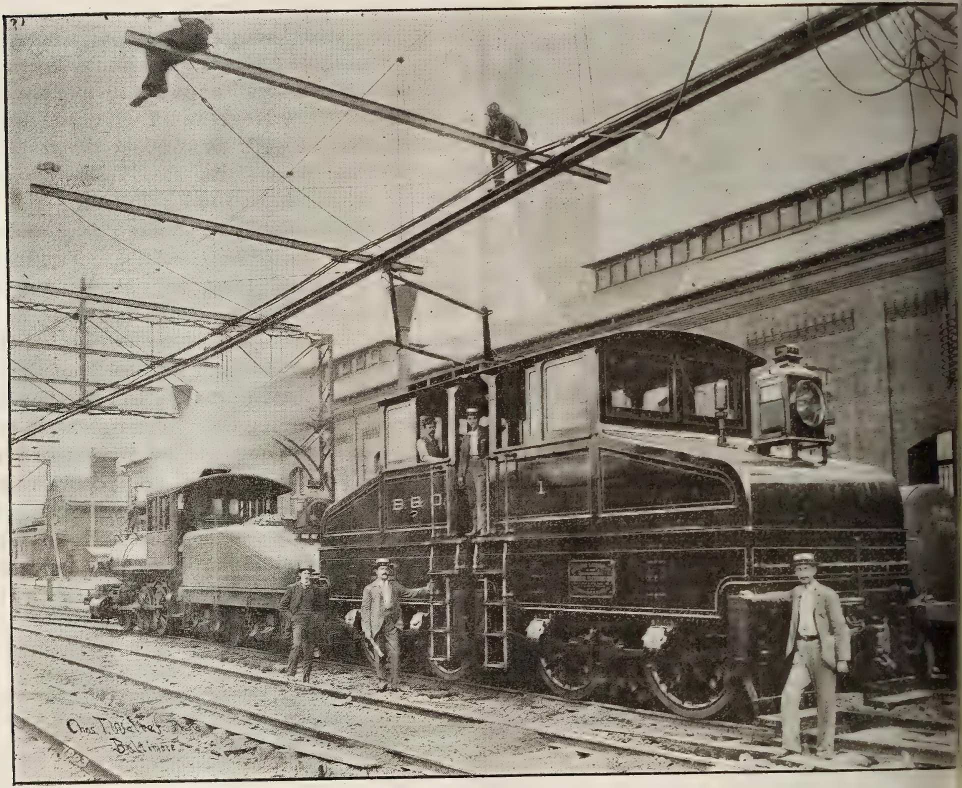
* 20 lbs. per ton for 11 ton train.

† 15 lbs. per ton for 30 ton train. 10 lbs. per ton for 120 ton train. The output required by train on a level will vary hin wide limits, with cars of varying weights and track in varying conditions.

Referring next to the controller, I may state that this has undoubtedly required as much attention and invention to perfect as the motor. The controller now generally used is known as a series parallel controller, *i.e.*: the motors are started in series with each other. This lessens the starting current for a given horizontal effort to half of that when the motors started together in parallel. It has been found that, in cities where the number of stops are frequent, by the use of the series parallel controller, the consumption of energ per car is lessened 40 per cent. Of course there would be no such gain in suburba districts where the stops are less frequent The different steps gone through in the starting of two motors by the series parallel metho are as follows :—

The two motors are started in series an with an external resistance, which is graduall turned out of circuit. One of the motors shunted with a varying resistance until sho circuited. It is then open circuited, with respect to the other motor, and, by means of varying resistances, the motor is finally brought into parallel with the second motor.

FIG. 2.



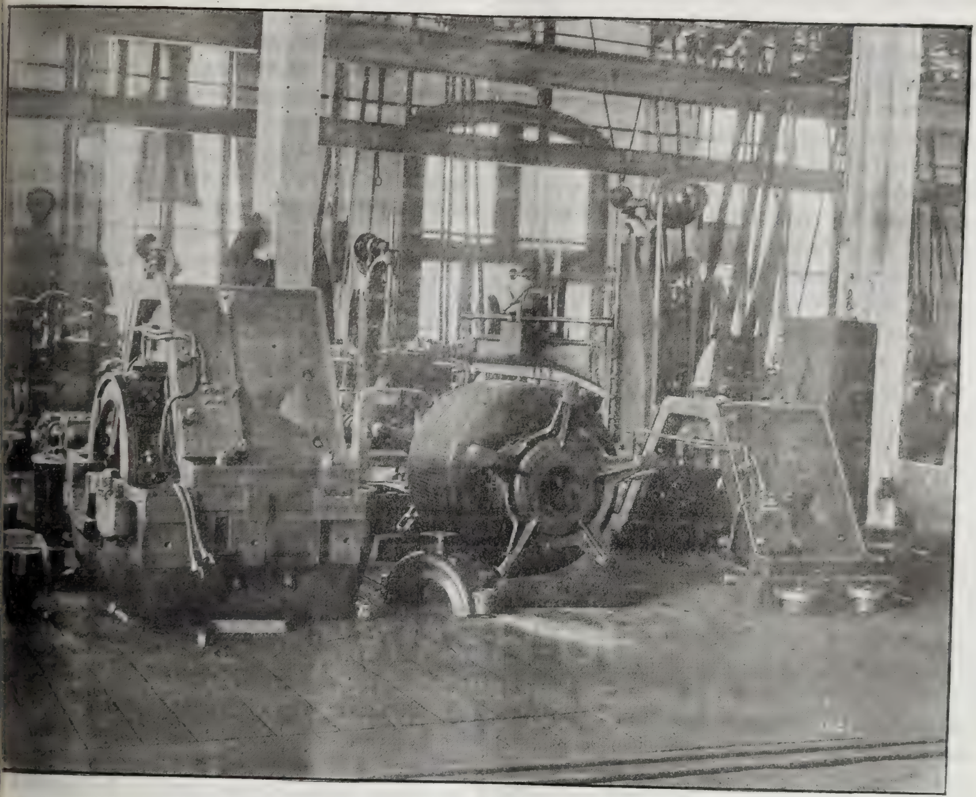
90-TON ELECTRIC LOCOMOTIVE, CONSTRUCTED TO OPERATE PASSENGER TRAINS IN THE BALTIMORE TUNNEL.

View shows Overhead Conducter, and the Contact-Maker or Trolley.

The most salient features of the developed controller are as follows :—Magnetic blow-out, placed wherever the circuit is to be broken, and which practically eliminates the burning of the contacts and greatly increases their durability; copper contacts used instead of brass contacts, it having been found that brass is less durable. Separate cut-out switc are used, so that either motor may be cut of circuit at the will of the operator. An in locking reversing switch is used so that mo can only be reversed when the curren turned. Safety braking switches are pla on the reversing switch, so that, in cas emergency, the power may be turned off the motors short circuited, so that they ac generators, in which case, the car is spee brought to a standstill. This method raking is what is known as the emergency ethod since it is not suitable for general use n account of the great strain put upon the otors. A method that is coming into use n the United States is that of connecting he motors, with their fields reversed, through he coils of a magnetic brake. This is ffected from the main handle of the switch nd the braking power regulated according to he position of the controlling cylinder.

Many of the features above mentioned in connection with the standard type of controller, are incorporated in the controllers for the larger motors, but, owing to the greater contract surface, and the greater amount of friction, special means have to be provided for turning the cylinder. In some controllers for four motors two separate switches are used, the two being operated by a single shaft by means of gears.

FIG. 3.



PARTS OF 300 H.P. MOTOR FOR 90-TON LOCOMOTIVE.

Showing Magnet Frame Armature on Hollow Shaft carrying the Driving Spider that engages with the Cushioned Lugs on the Driving Wheel.

Before leaving the subject of the series rallel controller, I present for your attention vo curves of the current taken in starting a r: first, by the series parallel method of ntrol, and, second, by the rheostatic method control. It will be noticed that the maximum rrent with the series parallel control is but alf of the maximum taken by the rheostatic ethod of control, in which the two motors are parallel. This sufficiently illustrates the dvantages of the series parallel controller.

Referring next to the progress made in electrical locomotives, I will illustrate, for your attention, a locomotive recently constructed by the General Electric Company of America for the Baltimore tunnel of the Baltimore and Ohio Railway (Fig. 2). The particulars of this locomotive are as follows:—

Number of trucks, 2; number of motors, 4; weight of driving wheels, 192,000 lbs; number of driving wheels, 8; draw bar pull, 42,000 lbs; starting draw bar pull, 60,000 lbs; gauge, 4 ft. 8½ in., and diameter of driving wheels, 62 in.; length over all, 35 ft.; height to top of cab, 14 ft. 3 in.; wheel base of each trunk, 6 ft. 10 in.; extreme width, 9 ft. 6¼ in.; diameter of sleeve bearings, 13 in. I illustrate the locomotive itself, construction of the overhead conductors, and also the tunnel in which the locomotive is to operate a heavy railway train. On this locomotive the particular form of overhead construction shown is worthy of notice. It consists of a shoe in an inverted channel. It was first intended to use the ordinary trolley, but it was found that the current density was too high for this work.

In the following lantern slides I show the assembly of the motor, and in a separate slide the details. The motor (Fig. 3, p. 399) has a rated out put of some 300 horse-power, and may be reversed at full load without any sparking at the brushes. The armature is, in this case, series wound. The fields are of six poles, three of them being long and carrying the larger magnet coils (this being made necessary on account of the space in which the motor has to be put), and three of the poles being shorter. These poles are wound with a number of turns consistent with the armature re-action. The thought will probably come to some as to whether or not it is necessary to put coils on these poles. I will state that it is, and that the construction shown is the best, since specific experiment has shown that the distribution of the field is better, and, likewise, the tendency to spark is greatly lessened, when all the poles of such a motor are excited. The armature is constructed on a hollow sleeve, the internal diameter of which is some 2 inches greater than the diameter of the axle. Motion is transmitted from the armature to the axle by means of a spider carried on a hollow sleeve, the extremity of the arms of this spider engaged with cushioned lugs carried the locomotive wheels.

This construction removes the dead weight of the motor from the axles and transmits it through the springs of the trucks. This is a great advantage, mechanically, in preventing hammering on the rails, and also a great protection to the windings of the motor from shock. A locomotive thus driven is remarkable for its smoothness and quietness in running.

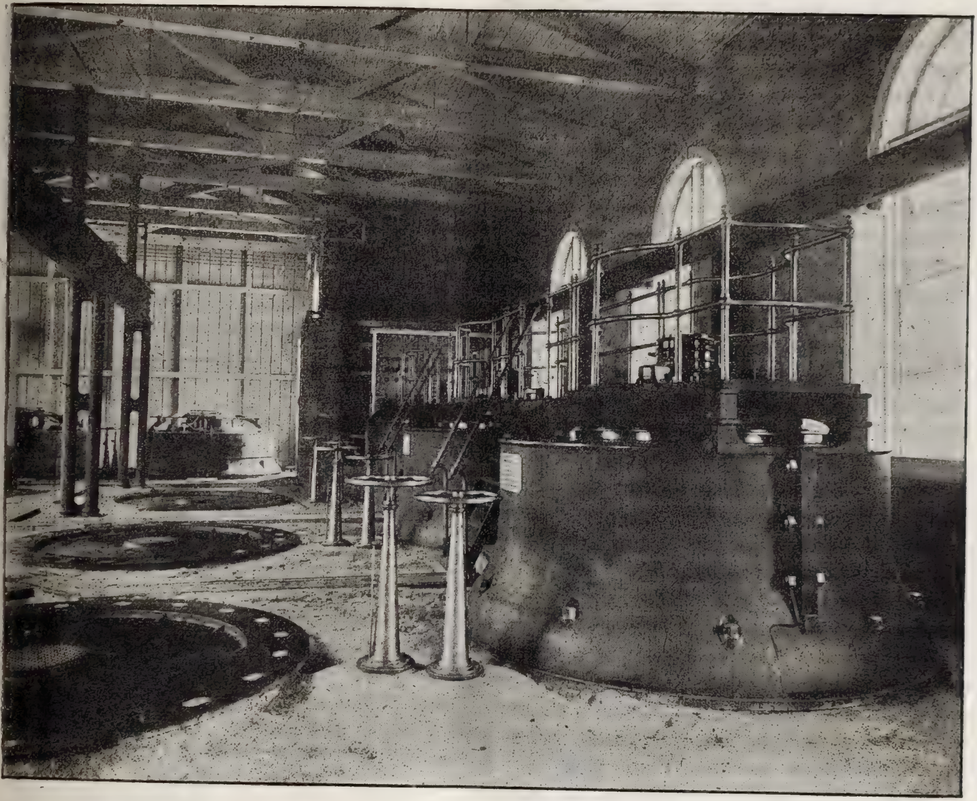
Both the electrical and mechanical problems involved in the construction of such locomotives are most difficult, but the experience has been ample to show that they have been fairly met and that a successful and, in all ways, satisfactory electric locomotive has been produced. The magnetic densities in the air gap of such a machine, and in the projections, have to be extremely high, being from 80,000 to 90,000 C.G.S. lines per square inch in the air gap, and from 150,000 to 180,000 C.G.S. lines per square inch in the projections, not allowing for the leakage between them, which is of course considerable.

Turning next to the appliances in the station, I would say that these also have been subjected to great improvement. Perhaps the most noticeable improvement is that of the substitution of direct connected generators for the belt-driven machinery at first time used, and I may here state that I do not consider large belt-driven dynamos suitable for electric traction work. The average work is greatly below the maximum work, if the driving belt is given sufficient tension to avoid slipping at the maximum load, the loss in the bearings is excessive for the average load. This objection, however, is entirely secondary to the mechanical objections of a belt connecting an engine with a dynamo subject to rapidly fluctuating loads.

The largest belt-driven dynamo that has been constructed in the United States is of 500 kilowatts output. The use of this machine is, however, becoming exceptional. The trouble experienced with the bearings, together with the considerable floor space and the greater cost of the machine as a whole, with no compensating feature in its operation, has led to the substitution by direct connected machines.

From 150 kilowatts capacity and larger, the belt-driven dynamos should not be used. In the extreme case, dynamos of not more than 200 kilowatts capacity should not be driven by belts or ropes. At the Exposition i Chicago was exhibited a machine of 2,00 electrical horse-power output, designed b me. The specification for this machin was that it should not heat more in an part than 30° C, should be subjected t variations of load, equal to its rated capacity without sparking, and should carry 50 pe cent. overload without dangerous heatin or sparking. Owing to the short time a the disposal of the makers, the dynamo wa first assembled and tested in Chicago, and wa found to perfectly comply, in all respects, wit the specification. The diameter of the armatur is 10½ inches, diameter of commutator 7 fee number of segments 696, length of commutat 18 inches, field magnets 12 poles, magne frame constructed of steel, the use of ste being found most economical. The construction of the commutator is worthy of special attention, the segments being held so as to equally expand along their length, and in such a manner that different parts of the commutator may be taken out without disturbing the remaining parts. Eleven of these machines have now been constructed from the original designs, and are working satisfactorily in the United States. Numerous smaller machines have also been constructed, and I herewith illustrate certain details that will make plain the method of construction. The commutator of the 1,500 kilowatts machine is illustrated. There are 7,000 lbs. of copper in this commutator. The weight of the armature is 86,000 lbs., and the weight of the machine complete is 180,000 lbs. I also illustrate groups of armatures and machines under test. The design of these machines to a given specification required very considerable study, both as to the density of the air gap in the armature reaction and the number of commutator segments; this problem has been accurately solved.

FIG. 4.

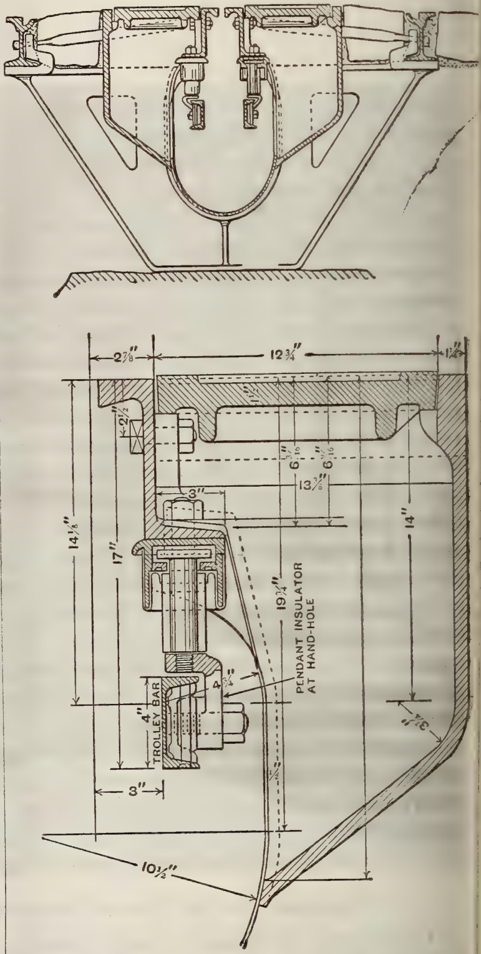


INTERIOR VIEW OF POWER TRANSMISSION STATION AT PORTLAND, U.S.A.

The Machines in the Foreground are 500 kilowatts 3-Phase Alternators, generating Current at 6,000 volts and 30 cycles per second. The Current is carried some miles away, and then converted into Continuous Currents for Tramways. The Machines in the Background are 250 kilowatts Continuous Current Generators. All of the Machines in this Station are carried on vertical shafts, and are driven by Turbines.

The transmission of power at a distance by means of multiphase currents and the distribution by means of motor-generators, and by so-called rotary converters (which is a machine running at a synchronous motor, but with closed circuit armature windings, the conductors being arranged so that commutation is effected) is now receiving considerable attention. I herewith illustrate the plant recently installed at Portland, United States of America. The source of power is from turbines. The type of alternator is shown in the accompanying illustration. The shaft is vertical and the weight of the armature is carried by a hydraulic bearing. The current is generated at a pressure of 6,000 volts and at a frequency of 33. This frequency is as high as the use of large rotary converters used in the sub-stations will permit. On account of the problems connected with the commutation of the currents the maximum size of a rotary converter is limited to the periodicity, *i.e.*, for comparatively high periodicities only rotary converters of small output can be constructed. I herewith illustrate a sub-station (Fig. 4, p. 401) in which are operated two 500 kilowatts rotary converters, the current being transformed down to suit the E.M.F. in the rotary converter. The ratio of the three phase voltage to the continuous voltage of the machine is fixed by the extent of pole arc of the field magnets. The ratio is generally about ·612. It may, however, be varied by varying the percentage of the pole arc of the field magnets. Experience with such machines shows that best results are secured when the currents are delivered in phase with the E.M.F. Either a lagging or leading current with respect to the E.M.F. of the rotary converter occasions more or less sparking. The distribution of the current among the armature conductors is a fit subject for a mathematical investigation, since the armature receives energy in the form of alternating currents, and delivers energy in the form of continuous currents. An examination as to the current distribution in a commutating machine with that of the current distribution in a synchronous motor, under many conditions, shows that the average effective current strength in the armature conductors is less than would be inferred from a separate examination of each. Thus, under some conditions of running it is found that the cross section of the conductors in such machines may be less than those of an ordinary commutating machine or of an ordinary synchronous motor. An investigation of the properties of this machine was recently carried out at Niagara Falls by the writer and other engineers of the General Electric Company of America. It was found, however, that owing to the condition of supply and the nature of the currents, that is quarter phase currents, the feature was but of little importance in practice. Recently I have designed the multiphase system for the distribution of power to electric tramways in Dublin. The object of the use of the three phase in this particular case is to comply with the Board of Trade requirements as to the drop of voltage in the earth return. In this case I have preferred to use synchronous motors driving commutating machines, the particular advantage in this being that the phase of the current, in respect of the E.M.F., may be regulated by the excitation of the synchronous motor. In the case of the rotary converter, this may not be done without varying the pressure in the consumer's circuit. There is also, in n opinion, some advantage in the use of synchronous motor over an ordinary stat transformer, the one being more easi repaired, and less liable to give way und the overloads that are frequent in tramw systems. It is not necessary to mention th

FIG. 5.

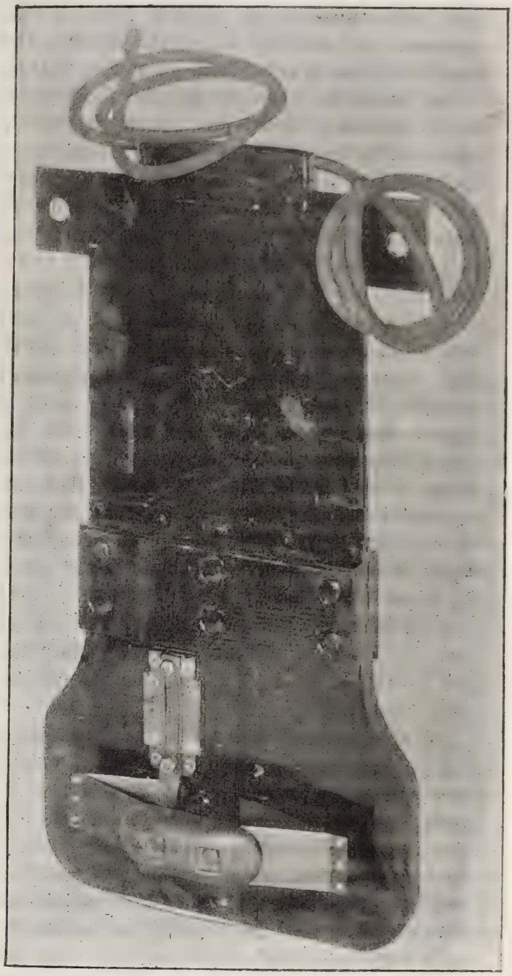


CROSS SECTION AND DETAIL OF CONDUIT R
CENTLY LAID DOWN IN NEW YORK CITY.

Cross Section shows the Cast-iron Chain and Braces
Machinery Alignment. Detail shows Method of Insulati
the form of Conducter, and the Principal Dimensions.

the three phase system is only used as a convenient means of transmitting power at a high tension. The three phase synchronous motors have the advantage of being self-starting, and there is also another advantage in that the amount of copper required is about three-quarters of that required in a simple alternating current system of transmission. Recently, both in the United States and in England, the subject of underground systems, such as conduits or systems in which the line is divided into sections, current being switched on in succession, or by the passage of the car over the sections, has received a good deal of attention. I herewith illustrate the form of conduit that has been successfully used in New York (Fig. 5, p. 402). The particular improvements made in this conduit over the earlier form are in its more durable construction, so as to secure perfect alignment and deeper conduit, so that there is less probability of trouble through the presence of water. The method of insulation has also been considerably improved.

FIG. 6.



CONTACT-PLOUGH USED IN THE NEW YORK CONDUIT.

The view shows the Central Web of Insulation. At the bottom is shown the re-placeable Steel Contact Shoe, one of which is carried on each side of the Plough.

I also illustrate the form of plough or contact maker that is used (Fig. 6). It will be noticed that this plough consists of a central web of insulating material carrying two contact pieces forced out against the conductors by springs. It has been a difficult problem to make this plough so that it is sufficiently durable. The plough illustrated seems to fairly meet the requirements. The cost of such a plough does not exceed £3. The maintenance in New York does not exceed ·0005 pence per car mile. Such a plough lasts six months, making 100 miles per day. The maximum speed is 17 miles an hour. The average high speed is about 12 miles an hour. The cost of this conduit is £17,000 per mile of single track. It has been stated that a conduit could be constructed that would be equally as good for less, but, in making this statement, the severe climatic conditions in New York had not been properly considered, and it is also to be borne in mind that former experience with conduits has indicated that, for anything like satisfactory results to be expected, the structure must be so laid that perfect alignment is maintained. Some similar conduits, but of less rigid mechanical structure, have been used in other American cities, but in no case is there encountered such severe climatic conditions as are to be met with in New York. The depreciation and maintenance of this particular conduit is less than any overhead system with which I am acquainted. The fact, however, remains that it is laid in a broad street, where there is perfect drainage and but little vehicular traffic across the rails, and that it is laid in a new part of the city, where troubles in laying from water pipes and gas pipes are largely avoided. The sectional rail and other systems in which there are switches at frequent points along the line so that a portion of it, less than the length of the car, is in circuit, are in an experimental stage. While I have seen some very successful models of such systems, the difference between a successful model and a perfectly working tramway appliance is so great that I shall not now discuss such underground systems.

I would call your attention to one of the details of the switchboard that has received great attention, and which has now attained to a very high degree of perfection, that is, the automatic circuit breaker. I have seen this circuit breaker open 6,000 ampères at 500 volts repeatedly, without burning the contacts, or making a serious flash. The circuit breaker is reliable in its action, that is, it can be set to open for any desired current with accuracy. It has been frequently observed by tramway engineers of experience that there is a great difference in the quality of short circuits, that is, when these circuit breakers are set for a given current the flashing is greater under some conditions, than under others. This has sometimes been attributed to self induction. The writer, however, does not hold this opinion, but a study of the switch will show that to maintain the necessary contact the weight of the moving part is appreciable, and it has therefore an appreciable time of movement. A short circuit may occur near the station so that the current that would flow in the circuit, were it not interrupted, would be much greater than from a short circuit taking place in some other part of the system. This, together with the fact that the circuit breaker requires a certain appreciable time for operation would explain the different results observed.

In conclusion I would say that another of the minor improvements that has been carried out with this respect to the bonding of the rails. It has frequently been found that with the resistance between metallic surfaces brought together under pressure is greatly in excess per unit of area of that of the conductor. The improvements in jointing or bonding the rails together is to greatly increase the area of the pressure contacts so that the current density does not now exceed the capicity of the contacts. The writer's experience indicates that, with a permanent system of earth contacts, the current density should not exceed 50 amperes per square inch. In large systems, where the return circuits amount to several thousand amperes, the rails themselves are frequently welded together electrically. Such systems have been satisfactory in action, and mechanical difficulties that were anticipated in a solidly welded system of tracks, have rarely been experienced.

DISCUSSION.

Captain GRIFFIN said he could add but little to what had been said, but some figures showing the development of electric tramways in the United States might be interesting. He had been connected for some years with the same company as Mr. Parshall, and had seen the development of these motors. In the year 1892, the total number of motors for street-car work turned out was 6,505; in 1893, 5,121; in 1894, 7,185; and for 1895, something over 8,000. These motors had been improved very greatly by experience, and by the best engineering talent available, the one illustrated being the standard for the last three and a half years. In May last there were about 13,000 G. E. 800 motors in operation all over the world, but principally in the United States. The series-parallel controller was one of the most useful inventions ever made in connection with traction work. The West End road in Boston, one of the largest systems in early days, when they used the rheostat, had some 800 cars, and a very large central station for developing the power for operating the cars, and being in the centre of the city the cars moved there at a very slow speed, and a tremendous amount of current was wasted in the rheostat; but since the series parallel controllers had been introduced, they had been able to nearly double the number of cars, without adding to the power station. The Baltimore and Ohio locomotive had been at work since August last, most satisfactorily; it had been able to haul with the greatest ease three ordinary freight trains, with their locomotives, weighing in the whole 1,900 tons. On one occasion the coupling broke in the middle of the tunnel, where there was a slight grade; and it was necessary to stop and start again on that grade; but it did this without the slightest difficulty or slipping of the wheels. Perhaps one of the most interesting developments of electric traction had been the underground conduit system. There was one in Washington on one of the principal lines; and he had recently received letters from the engineer, as also from the engineer of the New York line, each stating that the working expenses on these lines were less than on any trolley road they knew of, and each of them had had vast experience. He believed all engineer would agree that they would much rather face the possibility of a larger first cost, if they could ensur a reduction in the working expenses afterwards. I appeared that on a recent occasion in Washington the drains and sewers in the vicinity of the line be came choked, and the water backed up into the conduit, filled it, and overflowed through the slot int the street. They reduced the voltage to 300, an ran for some hours under those conditions withou trouble. He believed the experience they were gaining in connection with these conditions would be o the greatest value to the electrical profession; an he knew that the working of the conduits wa being watched with the greatest interest by engineers all over the world. So far, all the report had been very satisfactory; and it seemed as if the only question, in any case, would be whether the conditions of the traffic would warrant the initial expense.

Mr. MANVILLE, after expressing his thanks to Mr. Parshall for his paper, said the one point which forced itself on the attention of all tramway engineers was the necessity of having, not only the best pieces of apparatus in themselves, but the grouping together of all the details in such a way that, from morning to night, no attention should be required after the cars left the depôt until they returned. That, he could bear witness, had been achieved in the apparatus which had been described. The progress of electric traction in this country had been retarded by the unæsthetic line construction which had prevailed in the United States, but that the conductors were capable of being arranged so as to be quite unobjectionable to the local authorities had been exemplified in the two most modern electric tramways, those at Coventry and Bristol; and he had no doubt that now much of the objection previously felt would be removed.

Colonel ALLAN CUNNINGHAM expressed the hope that electric traction might be introduced on the Metropolitan Railway, and so save the very numerous passengers who made use of it from the great annoyance of smoke, dirt, and objectionable fumes from which they now suffered.

Mr. W. M. MURPHY (Dublin) said he possessed no special knowledge of electricity, but he was interested in tramways, and last autumn he went to America and saw a great deal of what had been just described. He must express his thanks to the General Electric Company of America for the great courtesy with which they showed him everything at their disposal. The extent of electric tramway traction in the States was beyond the conception of anyone who had not seen it, and the system seemed to have pretty well reached finality, unless some new method of producing electric energy were discovered. Mr. Parshall had described various machines, but his modesty had prevented his adding that he himself had perhaps done more to bring the generator to perfection than any other man in the United States. He remembered a similar incident on the Baltimore and Ohio line to that mentioned by Captain Griffin when two steam locomotives failed to start a heavy train, and in their efforts jerked the coupling chain and broke it, but the electric locomotive walked away with it with the greatest ease. According to his experience Great Britain was behind the whole world in the matter of electric traction, and he could give his friends in America no better illustration f it than by telling them that the city of Glasgow, having acquired the tramways a little more than a ear ago, bought a new horse plant to work hem instead of an electric plant. No doubt one great difficulty was the state of the law. Most tramway companies in this country had a clause in their Act of Parliament which said that the line should be worked by animal power only, and in order to substitute electricity or any mechanical power they had to obtain a new Act, which meant great delay and expense, especially if any opposition were offered by the local authority. If those interested in electric traction would get a public general Act passed enabling tram companies to come to an agreement with the local authorities for working the lines by mechanical power, subject to the approval of the Board of Trade, and to any restrictions such Act might impose, he believed it would give a great impetus to the industry.

Mr. DEVONSHIRE, being asked by the chairman to state what progress had been made in Bristol, said the company had just issued a balance-sheet for the half-year ending December, 1895, but there were not very many details given. It appeared, however, that on the short length of four miles, over one million passengers had been carried in four months. No figures as to the cost per car mile were given, but, whenever the Board met, which was once a fortnight, the chairman always seemed remarkably pleased at the traffic receipts.

The CHAIRMAN said he was sure that everyone who travelled on the Metropolitan Railway, as most people in that room had to do sometimes, would re-echo the wish expressed by Colonel Cunningham, that that line should be worked by electricity. He had not the least doubt that sooner or later that would be done, for the conditions of that traffic would render it economical. One objection which had been raised was that nearly every railway having a terminus in London had running powers over the line, and therefore steam must be used; but the experience of the Baltimore and Ohio, of which they had just heard, showed the futility of this objection; the trains of any railway might be hauled over the line by electricity just as well as by the present system. The important point was, that such traffic as that of the Metropolitan Railway could be carried more cheaply by electricity than by steam; there were frequent trains, running constantly, and giving what electricians wanted, a full day load and a good flat curve. Those were just the conditions which enabled one to produce electricity at the very lowest rate. In London, electricity was being supplied for lighting purposes at from 5d. to 8d. per unit, but it was quite possible to produce it, and it was being produced in Manchester, at less than 2d.; and if they could produce it during the whole day of 24 hours with a constant full load, which would keep the apparatus at work at its maximum efficiency, electricity could be generated at from ¼d. to ½d. per unit. On the Metropolitan Railway there was very nearly that state of affairs, so that energy could be applied to drawing the trains more cheaply in the form of electricity than by means of steam. An increase in the number of trains worked by electricity would reduce the working expenses, but an increase in the number of steam locomotives would add to those expenses; the cost by steam would go up, while the cost by electricity would go down. When this fact was appreciated by the directors, they would, no doubt, begin to think seriously of applying electricity. They must all have been struck by the gigantic character of the apparatus shown on the screen, especially those who had not been in America. He spent two or three months there in 1893, saw many of these things at Chicago, and rode on the 30-ton locomotive during the test; but he did not see the 96-ton locomotive, and there was one question he should like to ask about it. It would appear that each of the 8 driving wheels must carry a weight of 12 tons, and he believed 7 tons wheel was the maximum weight which should allowed, according to the experience of railway engineers, both here and in the States. He should, therefore, be glad if Mr. Parshall could give any information as to the behaviour of this locomotive under such an unusual strain. Reverting to the economy of generating electric energy under a continuous flat curve, he thought that was a point which would appeal very powerfully to local authorities, conservative in spirit as they generally were. When it was brought home to them that the introduction of electric tramways would give them a constant day load, and enable them to reduce the cost of electricity for the purpose of lighting at night, they would probably look favourably upon it. Mr. Manville, in his modesty, had not referred to the great pioneer scheme which he had inaugurated in Swansea, which was of this kind. The corporation were to establish a central station for electric lighting, which would only be required for a few hours in the evening; but it was proposed to supply the tramway company during the day with a million units of electricity per annum, at a very low price. If the tramway company worked its system by electricity instead of horses, the result would be that it would cost them about 1½d. per mile instead of 4d. for horse power, while the charge per unit for lighting would be reduced to 3d. or 4d., instead of 6d. or 8d. If this could be done in Swansea, why could it not be done in other towns, to the great benefit of the ratepayers and users of electricity. He heard that the growth of traffic in Bristol since the introduction of electricity, had been very satisfactory, and the same thing had been noticed in America. On the same roads with the same cars, what was called the factor of public satisfaction, arising from the quicker rate of travelling and other improvements, had increased the amount of traffic by some 30 per cent. He had just returned from inspecting a very interesting application of electricity to lighting and tramway working in Rome. The electrical energy was generated at Tivoli, 18 miles off, where there was a splendid water service. A station had been constructed there, to develope 2,000 horse-power by means of six turbines, which was converted into alternate currents and transmitted to Rome, where it was transformed from 6,000 volts down to 110, and was used for lighting. They were now using the day load to work the tramways, the alternate currents being transformed down and rectitified, and used to charge a very large secondary battery of 304 cells, of 1,200 ampère-hour capacity. During the day the trams were worked direct, and during the night the same current was employed for lighting, the secondary battery being used to supply energy to the tramway during the time when the two services overlapped, and also to maintain the pressure constant during the whole period. The installation at Tivoli had been described several times, but the secondary battery system had not. Prof. Mengarini, however, had promised a paper upon it, and he never met any one who combined in a greater degree the insight of a thoughtful scientific man with the capacity for overcoming practical difficulties, which characterised the engineer. He should like to ask what was the general practice in America on the question of direct driving as against belt-driving, because he was rather surprised sometim ago to see direct driving described in a technica paper as a fad. He concluded by proposing a cordial vote of thanks to Mr. Parshall.

Mr. PARSHALL, in reply, said that the questio of the weight on the driving wheels in the larg locomotive was very carefully considered, but tha the great difference between it and an ordinar steam locomotive was that the angular effort wa so uniform. There was no oscillation and n vibration, and it was found that the bearing could be made considerably smaller than woul be necessary with a steam locomotive. So fa there had been no trouble with the bearings. A to belt driving *versus* direct, he might say that th firm with which he was connected had built abo 200,000 horse-power of direct-driven machinery; fact, three-fourths of their total product consisted direct-driven generators, and these were alwa advised when people were willing to pay for the be possible apparatus. In pioneer works, however, small towns, economy in first cost was sometimes important consideration. Belt-driven machinery w not suitable for large tramway operations, as t load was so much affected by the belts bei put on and off very much at the discreti of the man who had charge of the circ breaker. He had been much interested in t remarks of Mr. Murphy, whom he last had t pleasure of seeing in the United States. He w also obliged to Captain Griffin for the figures he h given, and although it was sometimes supposed th Americans were disposed to make exaggerated sta ments, he could assure them that any stateme expressed by Captain Griffin could be fully rel upon.

IFTEENTH ORDINARY MEETING.

Wednesday, March 18, 1896; Sir HENRY ORMAN, G.C.B., G.C.M.G., in the chair.

The following candidates were proposed for lection as member of the Society :—

ackison, William, 8, Constitution-terrace, Dundee.
anning, John Robert, Milkwood Estate-office, Herne-hill, S.E.

The following candidate was balloted for, nd duly elected a member of the Society :—

pton, Prescott, City and Suburban G.M. Co., P.O. Box 1026, Johannesburg, South Africa.

The paper read was—

THE SISAL INDUSTRY IN THE BAHAMAS.

By DR. D. MORRIS,
M.G., M.A., F.L.S., Assistant-Director of the Royal Gardens, Kew.

The Sisal industry has been started within e last few years in a portion of Her Majesty's ossessions that does not often come under the otice of the British public. The Bahama slands form an archipelago of coral lime-one, appearing on the map like stepping ones for giants, extending in an irregular ne from south-east Florida to Hayti and San omingo. There are about 20 inhabited lands. The total area is 4,466 square miles, about one-half the size of Wales. The opulation in 1891 was 47,565. It was one of e Bahamas group that formed the first ortion of the New World discovered by olumbus on his memorable voyage in 1492.

I have lately returned from a winter vaca-on in the Bahamas, and at the request of e Council of the Society of Arts I venture to lace before you the results of my observa-ons in regard to the Sisal industry. I am ware that a good deal of interest is being ken in the industry, and there are many in is country who are anxious to hear what n be said as to its present position and ospects. I have already given a sketch of e history of the subject in the course of antor Lectures on "Commercial Fibres" elivered before the Society in March and pril of last year. These lectures have since een published in a collected form, and are cessible to all who desire to possess them. need not, therefore, repeat what I have said ere as to the successive steps taken to start the industry and to draw attention to it as a means of increasing the welfare and prosperity of the Bahamas, as well as affording a promising opening for the investment of capital from other countries.

I admit that, purely from an investor's point of view, the main object in a matter of this kind is to find a remunerative return on capital. But I feel sure that every true-hearted Briton would prefer to benefit a portion of his own empire rather than a foreign state, and especially while he may, at the same time, enlarge the possibilities of finding a larger market for the manfactures of the United Kingdom. This may be one way of solving the problem of the unemployed. If we increase the prosperity and well being of the Colonies, we increase their purchasing power, and therefore their capability to support an extended commerce with the mother country.

In treating of Sisal in the Bahamas, it is impossible to overlook the fact that it owes its existence, as a commercial undertaking, entirely to the devoted and able efforts made for many years in its behalf by the late Governor, Sir Ambrose Shea. This fact is widely recognised. In the speech made by the present Governor, Sir William Haynes Smith, at the opening of the Bahamas Legislature on the 4th ultimo, it is re-stated in the following words:—"The colony owes a debt of gratitude to Sir Ambrose Shea for the energy and ability with which he urged the cultivation of Sisal, and attracted capital to the colony. This industry is now in the hands of companies and persons having the command of large means, and I trust the success of the enterprise may be considered as assured."

I would add that, from my own observations, I feel convinced that under the sympathetic control of Sir William Haynes Smith, Sisal in the Bahamas will be wisely and consistently encouraged so that it may become a large and permanent industry.

THE SISAL PLANT.

Sisal fibre derived its commercial name from the port of Sisal, from which it was originally shipped. Since the completion of the railway to Merida, the fibre is now wholly shipped from Progresso. In Yucatan the plant is called Henequen. There are two sorts, white and green. *Henequen blanco* is the plant known by the aboriginal name of Sacqui. It has a whitish bloom on the leaves, giving them a glaucous colour. It has teeth on the edge of the leaves, and is botanically *Agave* *rigida*, var. *elongata*. This is the chief plant cultivated in Yucatan. *Henequen verde* is the aboriginal Yaxqui. This has no teeth on the side of the leaves. The colour is a bright green, and is botanically *Agave rigida*, var. *sisalana*. This is the Sisal plant of the Bahamas. In this paper we shall refer to it briefly as *Agave sisalana*. It is universally regarded as yielding the best quality of fibre of any known Agave.

This Agave, now so closely associated with the fortunes of the Bahamas, has had an interesting history in another part of the world. For a knowledge of its culture and uses, Dr. Schott tells us Yucatan is indebted to the Maya Indians—the direct descendants of those remnants of the Toltecs who, after the fall of their empire in the valley of Mexico, emigrated to Central America and Yucatan. Some of these Indians, still speaking the Maya language, are found within the borders of British Honduras. They are most skilful in extracting fibres from all kinds of native plants.

As regards the botanical name, we are told by Dr. Engelmann that "*Agave sisalana* was given by Dr. Perrine to the plant known to the natives of Yucatan as Yaxqui, the most valuable of the fibre-producing Agaves which was introduced by him into Southern Florida, in 1836, during his efforts to acclimatise commercially valuable tropical plants in that portion of the United States." He did not live to see the success of his efforts, but the Yucatan Agave is now fully naturalised in Florida, at Key West and the adjacent coast. It is abundant also in the Bahamas, but whether derived from Florida or directly brought to the Bahamas by other means, it is now impossible to say. Mr. C. R. Nesbitt, a former Colonial Secretary, introduced fibre plants direct to the Bahamas in 1845; these may have been *Agave sisalana*. On the other hand, I recently found a new species of green Aloe (*Fucrœa*) growing in the neighbourhood of Nassau, that yields fibre, and it is not impossible that Mr. Nesbitt's plants were these. The point is not, however, of practical importance at the present time, but Mr. Nesbitt deserves credit as being one of the earliest, if not the earliest, persons who took a deep interest in the efforts to start fibre cultivation in the Bahamas. It is in favour of the theory that the Sisal plants came from Florida, as in the nearest islands, such as Abaco, the plants are most abundant, and this fact has led to their becoming the headquarters of the industry. The migration of such heat-loving plants would naturally be southwards in the direction of the greatest warmth. Their migration northward has been shown to be very limited. If the dispersion began from New Providence, the northern islands should have possessed fewer instead of the larger number of plants.

Agave sisalana, in common with other plants belonging to the same family, possesses special provisions for spreading itself over a wide area. These provisions are either vegetative or seminal. The vegetative reproduction is of two kinds. There are first of all underground suckers thrown off from the stem which grow up around it. Until they are large enough to shift for themselves, these draw their nutriment from the parent plant. Suckers appear about the second or third year after planting; they continue to be thrown off for a year or two, and then cease altogether. The period when they actually cease is probably determined by the approach of the "poling" stage, when the plant is about to come into flower. This is the supreme effort in the life of many plants of the Agave tribe, and with it they complete their life history. The flowering panicle or "pole" is a huge inflorescence, sent up from the heart of the plant. It is 15 to 20 feet high, and sometimes higher. The base is about 4 inches in diameter, and it gradually tapers upwards into a fine slender rod; the branches are carried in the upper part only; they come out almost at right angles. The height of the panicle is usually about 12 to 14 times its width, and the largest branches are near the middle. The branches carry numerous greenish-yellow flowers, giving the whole a candelabral character. In *Agave sisalana* the flowers are seldom followed by seed pods exceptionally, one or two may be produced When the flowers have fallen, the pole does not immediately die away; on the contrary at the ends of the branches, in the axils near the flower scar, there are produced numerous small bulbils, which eventually develop into plantlets of considerable size. These are locally called "pole plants." We have seen that the Sisal plant is capable of being abundantly propagated, either by means o root suckers or pole plants. Of the relative merits, from the commercial point of view, o these two methods of propagation I will speak later.

DISTRIBUTION OF SISAL PLANTS.

Agave sisalana had its original home, a already stated, in Mexico. On account of it value as a fibre plant it has now been widely distributed in tropical and sub-tropical countries. It was introduced as we know to Florida and the Bahamas, and is found also in considerable quantity in the Turks or Caicos Islands, where there are several plantations already established and apparently in a thriving condition. The plant is present in Jamaica in considerable quantity. It was introducd there from the Turks Islands during the last seven or eight years. No regular plantations have been established, although experimental areas under 100 acres exist in some parts of the island. In 1884 I strongly recommended Sisal cultivation to the people of Jamaica, and showed that at the prices then existing the net yearly returns would have been at least £5 per acre. If it had been possible to ship fibre from Jamaica during the period of high prices in 1889 the net return would have been as high as £20 per acre. Although the opportunity was missed it is a fortunate circumstance that Jamaica, at the present time, has many other industries of a successful and prosperous character.

In British Honduras, as might be expected from its contiguity to Yucatan, there exist numerous plants of Henequen, both of the white and green varieties. It was here that I irst saw Sisal plants during my exploration n 1882. Small areas have been planted in he northern parts of the colony in the neighbourhood of Corosal. Samples of fibre from British Honduras, received in 1891, were eported by Messrs. Ide and Christie to be of 'good style, quite of the Sisal hemp character, and readily saleable in the London market." Trinidad imported about 12,000 small plants rom Florida in 1891. They were grown in iurseries, and afterwards distributed to Tobago and various districts in the island. No attempt ias been made to start a fibre industry. A mall sample of fibre cleaned at the Botanic arden was of excellent quality, so that both he soil and climate have been proved to be avourable to the production of commercial ibre. In the Windward Islands during 1890-91, about two acres were established at the Grenada Botanic Station; a smaller area at he St. Vincent Station; and about 5,000 lants were introduced to St. Lucia. In the Leeward Islands, plants exist at Antigua and St. Kitts. A fairly large plantation of *Agave isalana* and *Furcræa gigantea*, started in he first instance by the Government, for relief urposes, exists at Anguilla. The plants are ow old enough to yield fibre.

The high price of Sisal hemp in 1889 attracted the attention of people in most tropical and sub-tropical countries to the possibilities of embarking in its cultivation. Plants were introduced in large quantities to the Cape, Natal, the tropical parts of Australia, Fiji, and various districts in India. In fact, it is hardly possible now to find any country in which they are not present in more or less quantities. They are present in one or two localities in West Africa, and are amongst the more common Agaves in gardens in the Riviera, where they flower freely. At La Mortola, Mr. Hanbury has several plants; one flowered with him in 1891.

Next to Yucatan itself it is probable that no part of the world is so favourably situated for carrying on a Sisal industry as the Bahama Islands. It may therefore be accepted that taking into account the comparatively limited demand that exists for the fibre and the fluctuations to which it is specially liable, the position taken up by the Bahamas will not be seriously contested by any other country.

In discussing the possible establishment of Sisal plantations in Florida, Sir Ambrose Shea stated:—"The cultivation in Florida has been proposed, but this is not seriously considered by us. The plant is inferior, wages much more than double what is paid here, and there is a well-known liability to frost which is fatal to fibre growth. As far as the best informed judgment can at present be a guide we have no grounds for apprehension that our position can be seriously disturbed, or that in any conceivable conditions in the future the fibre cultivation in this colony will be placed below the limits of profitable adventure."

SOIL.

The Sisal plant does not require a rich soil. The fibre districts of Yucatan have generally a rocky broken surface composed of a layer of soil about eight inches thick, underlaid with a soft limestone rock. The general conditions are dry and arid. The rainfall is small, falling usually within two or three months. For the rest of the year there is little or no rain and the heat is intense. The Sisal plants can withstand this heat provided there is some soil; but on the other hand it is important to point out that the impression which unfortunately has become general in the Bahamas that Sisal plants will thrive on the poorest soils or practically on no soil at all is a misleading one. This impression has led to some lands being cleared and planted with Sisal that are likely to prove utterly useless for fibre growing. It would be well to bear this in mind, both in extending the present plantations, and in selecting sites for new plantations. What are called "mixed lands" and "coppiced lands" of an undulating character appear to be very suitable for the purpose; whereas "pine lands" of the typical sort, with but a thin film of soil overlying an almost impenetrable pavement of limestone rock should be carefully avoided. Again, in the Bahamas, there are many depressions inland where there is water lying a foot or two below the surface. This is fresh water, but is sometimes influenced by the rise and fall of the tides. In such localities it would be decidedly unwise to plant Sisal. The plants are most sensitive to moisture at the roots. They either die outright, or linger on in an unhealthy condition, making little or no growth.

Mr. James M. Rae, in a report published at Nassau, in 1891, was very emphatic on the importance of planting Sisal in suitable soil. He pointed out the improbability of the plants "thriving in dry, arid sand, or on rocky land devoid of soil." Subsequent experience has confirmed this. The same writer also draws attention to the healthy appearance of plants on hilly slopes fully exposed to the sun and air. This, in part, is no doubt due to the excellent drainage of such situations. Rocky land is by no means to be avoided provided it is "loose broken rock," and not an impervious pavement. In the former there are numerous interstices and small pot holes containing soil in which the roots find abundant food. There is no lack of suitable soil in the Bahamas. In fact, from my own observation, I am able to state that there are extensive areas where the plants already established are most luxuriant. It is only necessary to look first at the plants, then at the soil, to arrive at the true value of almost any situation for Sisal hemp plantations.

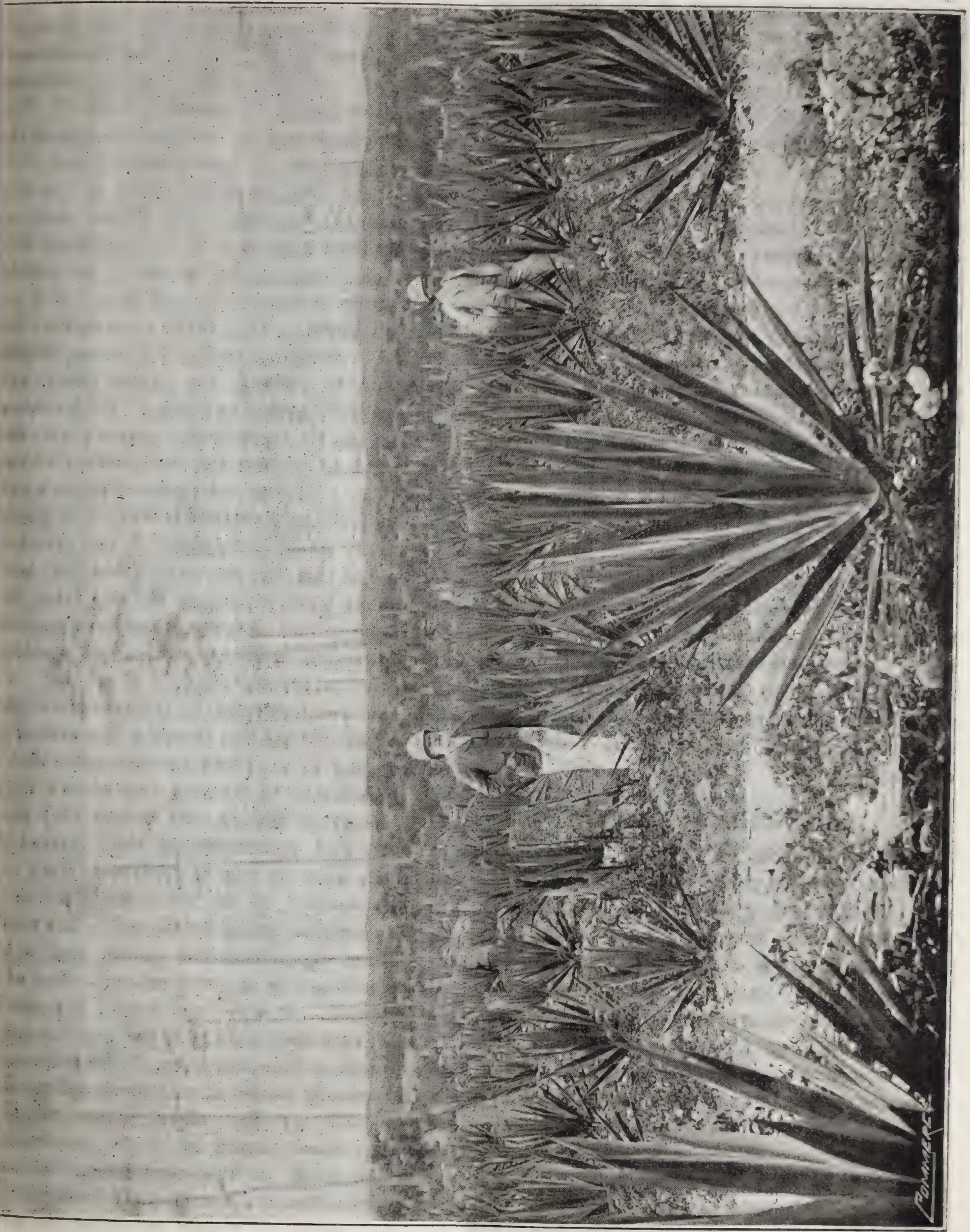
Mr. Preston, writing of Sisal in Yucatan, stated :—"Although not apparently subjected to disease, and capable of resisting a drought of eleven months in twelve, the plant is not altogether free from the effects of sudden changes of heat and cold, and is liable to be damaged by floods of rain immediately after a long drought, when accompanied by sudden fall of temperature. This happened in Yucatan in 1888, when, after a severe drought, the rains came on suddenly, with hail and a heavy wind from the north-west, with a fall of temperature from 89° to 57°, and within one night about 90 per cent. of the plants were damaged or blasted on the ends of the leaves, about an average of three leaves to the plant being affected, causing a loss of 3 per cent. of leaf. A similar change, after a protracted drought, happened in this colony in March last, when a few of our farms were affected." Such a visitation happens but once in many years. Apart from this there is no serious injury likely to arise to the plants. The hurricanes of the West Indies do not affect them on land beyond the reach of floods and sea-spray.

CULTIVATION.

The selection of the land, based on the character of the soil, elevation, and aspect having been determined, the next point is clearing it ready for planting. Where the growth is "coppice," or low bush, there is not much labour involved. Where it is pine land, there is heavier cutting. Both cutting and lopping are better done in the dry season. The subsequent burning should be as light as possible. In the Bahamas the less burning the better. Where the soil is thin, it is most injurious to pass a big fire over it. Where practicable, the dried timber, after felling, might be arranged in rows and heaps, and burnt there only. This would save the soil in other places. Where there is a demand for charcoal some of the hard wood might be utilised in this manner.

Nurseries.—In all cases, I would strongly recommend the establishment of nurseries in a central position, where suckers might be grown until they are about 16 to 20 inches high. For reasons given later, I would select suckers in preference to pole plants. Suckers, when so grown, can be kept under observation, and selected for planting according to their strength and vigour. It also saves much expense in weeding in the fields, if there are no young plants to care for. When plants are lifted from the nurseries, it is usual to trim the roots and remove some of the lower leaves before they are planted out. In the case of established plantations this plan is to be recommended. It tends to lessen the subsequent production o suckers, and thus gives the plant greater vigour When the roots are not trimmed, the plant is said to produce an abundance of suckers, and is probably thereby weakened. In any case it will produce a sufficient number for renewing the plantations. Any further production means loss of leaf-growth.

Planting.—It is an advantage to put ou the plants in rows exactly the same distance part. This facilitates the work and allows r subsequent planting between the rows. he distance between the plants in each row ay vary according to the character of the land. In very rocky land advantage must be taken of the small "pot holes." It is useless to plant elsewhere. Lanes for carting purposes and railways are left between every



Sisal Plantation in the Bahamas.*

urth, sixth, or eighth row, according to the ture of the ground. The number of plants the acre will vary from 600 to 800. The ndency is to plant closer than formerly. As ng as this does not interfere with the growth of the plants and affords room for cutting close planting is not necessarily injurious. On some plantations 1,000 plants are found to the acre. This is possibly too close on good land, and may result in the production of short leaves, which is to be avoided.

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* The block of this illustration is kindly lent by the Editor of *Commerce*.

Cutting the Leaves. — If large healthy suckers from 16 to 20 inches high are planted these should yield leaves fit for cutting in about three to four years. The proper time for cutting depends on the soil and the vigour of the plants. During the first season of yield only a few of the largest leaves should be removed. Subsequently 10 to 15 leaves may be cut from each plant. This may be continued from once to thrice a year according to the age and character of the plants. Over-cutting is a serious mistake. The fibre is immature and consequently of low commercial value. The practice also brings on premature polling, and thus injures both the reputation and the permanency of the plantation. The leaves may be cut by contract and tied into bundles of fifty at a cost of about 1s. 6d. per thousand. They may be conveyed to the cleaning sheds on mule back, in carts or by light railways. A mule will carry 200 leaves; on a railway he can draw a waggon with 3,000 leaves. In Yucatan and also in the Bahamas portable railways have been laid. These are of 50 centimetre gauge, rails 10 lbs. to the foot. The material for the most part is the French Decauville system. The Belgians also, according to Mr. Pierce, supply large quantities of this portable railway, rails and sleepers combined costing about 1 dol. 12½ cents. per metre.

POLING OF SISAL PLANTS.

A question arose in 1893 as to the early "poling" of Sisal plants in the Bahamas. It was felt that if they began to pole at five to seven years there was little time in which to obtain a succession of leaves to carry on the industry. The details of the investigation made at that time are fully given in the *Kew Bulletin*, 1893, pp. 315-319. Those specially interested in this aspect of the question cannot do better than refer to the *Bulletin*. The aid of Kew was sought in reference to the approximate time the Sisal plant would last in the leaf state. In other words: How long would the plant be available to the planter for the production of fibre? The matter was felt to be one of great interest to the Bahamas people, for on it depended the success of their plantations. The result of the inquiry was so far satisfactory that, with care and judgment on the part of those directly in charge of the plantations, it was felt that no greater cause of anxiety need be felt in the Bahamas than had been felt during the last thirty years in Yucatan, for plants that had poled might easily be replaced, from time to time, by strong healthy "supplies" from nurseries, and the work of the plantations need not at any time be interrupted. The latest information from Yucatan was furnished by Mr. Pierce, the Vice-Consul at Merida. He stated that "hemp plantation in Yucatan lasted for some 15 years." This was not conclusive as regards the age of the individual plants. It merely showed that while some of the original plants poled at one age and some at another, their places were so filled up from time to time by new plants tha the whole undertaking received no serious check up to about the fifteenth year. It is believed in Yucatan that if the root-suckers are allowed to remain attached for a long period they tend to exhaust the parent plant, and accelerate the period of poling. Such sucker diverted the strength of the parent plant, and if allowed to remain too long, either of two things must happen—the parent plant would produce fewer and smaller leaves, or its period of maturity would be hastened. The practica outcome of this was the suggestion that suc suckers as were necessary for supplying th plantation should be taken, when large enough into nurseries, and all others be remove regularly and thrown away.

The information from the Bahamas in regar to the plants that had shewn a disposition t early poling in 1893 was so incomplete that was impossible to discuss the matter fully The history of the suckers before they wer put out, and the treatment they afterward received, were not given. All these were important factors to be considered before definite opinion could be formed. The resu of further experience has shown that som plants pole at five or seven years; others at later period. It was improbable, if proper treated, that they would all pole, over a larg plantation, at the same time. If the plantatio were carefully watched, and fresh plants p in as soon as the older plants reache maturity, there would be little interferen with the work of the plantation. It wa further considered essential that fresh plant in large numbers, should be grown in nu series with the view of supplying vacanci caused by poling. Also that the pole shou be cut or, better, notched and bent over, soon as it appeared, in order that all t leaves on the plant should be ripened before died. In this way the plant would be ke vailable for yielding fibre for nearly a year ater than it otherwise would be.

Another point was insisted upon, viz., that vhile all the mature leaves should be cut when hey had attained full development, great care vas to be taken that the immature leaves were ot cut. The regular cutting of the fully natured leaves was understood by some to rolong the vegetable life of the plant, and etard poling. Theoretically, however, there s no ground for such a supposition ; on the ther hand, the cutting of immature leaves vould certainly have a contrary effect. The lant would be likely to be weakened by the rocess, and the subsequent leaves borne by it ould be fewer and smaller. The exact period hen the leaves were to be cut required care-l attention. As a general rule, the leaves ere ripening when they were gradually falling om the erect to the horizontal position on the lant. There were also some indications in e change of colour of the leaves. It is some-hat of a coincidence that exactly similar estions arose in Mauritius, when the hemp dustry was started there some twenty years go. The plant cultivated in the island is the reen Aloe (*Furcræa gigantea*). It is similar the Sisal hemp in appearance and habit ; it so produces bulbils or pole plants after flower-g. M. de Chazal stated that the plants enerally poled there at the age of seven to ght years, but they could be cut four or five mes before poling, and therefore before it was cessary to replace them. Another account entioned that many of the Aloes flowered ree or four years earlier than others ; hence e leaves of the seedlings from the former ere fit for cutting when the late-flowering ants were dying out ; so cutting once begun as practically continuous. Supplying amongst d plants was done in time so that, as the d ones died out, cutting from the young ones as ready to begin. Over-cutting in Mauritius as held to be injurious to the plants, weaken-g their growth, and causing them to flower, d die prematurely. In Mauritius, also, it as found that, by cutting only the matured aves, the growth of the plant was not akened. Thus large fine leaves were tained yielding long fibre of the finest ality.

There is another important factor, appa-ntly overlooked, in regard to the poling of sal plants in the Bahamas. In Yucatan the antations are established for the most part th suckers not pole plants. The latter are t often available, for the pole is removed as soon as it appears. Owing to the heavy demand that existed a few years ago in the Bahamas pole plants were very largely used. In fact in many cases they were the only plants used. Added to this they were mostly small in size, and conveyed in large quantities in the hold of schooners where they got over-heated and weakened. Such plants were necessarily predisposed to early maturity. I am also of opinion that pole plants produced as an expiring effort of the parent plant are not always calculated to produce such robust plants as suckers. At least they are not likely to be so when derived from plants whose leaves are periodically reduced when cut for fibre purposes. It would be well to investigate the matter experimentally. This might be done by planting suckers and pole plants side by side and watching the results. On no other grounds should there exist any marked difference between the behaviour of Sisal plants in Yucatan and the Bahamas.

Extracting the Fibre.

In Yucatan the greater part of the 350,000 bales of Sisal exported from that country is cleaned by means of a primitive machine called a "raspador." Although of a rude character it is stated that a *peon* thoroughly experienced in the work will clean at the rate of 20 leaves a minute. There is, however, a considerable waste of fibre, and the work is laborious. The average work of one machine per day is said to be 7,000 leaves with two men continuously engaged in feeding it. The raspador is simply a wheel, like a 4-foot pulley, with a 6-inch face, furnished with pieces of brass an inch square and 6 inches long running across the face a foot apart. This wheel runs in a heavy wooden case. When working it makes about 110 to 200 revolutions per minute. The leaf is put in through a small opening at one end, and is held by a strong clamp or in the hand. In the meantime a heavy block, like the brake of a railway carriage, worked by the foot, is brought to bear on the part of the leaf hanging down, pressing it against the revolving wheel. In a few seconds the pulp is beaten out and thrown into a pit underneath the wheel. The cleaned fibre is drawn out and held in the hand. After this the leaf is reversed and the other end cleaned in exactly the same manner. It will be noticed that the leaf has to be firmly held by the operator while it is being cleaned ; it has further to be pressed by the brake against the blades of the revolving wheel, and when one half is cleaned it is necessary to reverse it and present the other half. In Yucatan, where men have been trained for the work for several generations, it is possible to continue this system. It was considered, however, to be very difficult if not impossible to introduce it elsewhere. Hence when the plants in the Bahamas were approaching maturity considerable anxiety was felt in regard to the means to be adoptod for cleaning the fibre. All the new machines that had been hitherto tried had not proved satisfactory, and at one time it was in contemplation to try a treatment by crude petroleum suggested by Mr. Edison. In the beginning of 1894 a machine was brought forward that raised expectations that fortunately since that time have been fully realised. The Governor wrote to the Secretary of State in May, 1894, to announce that he was in a position to speak definitely of a fibre machine that was in successful operation in the colony. "The machine in question," he says, "is manufactured by Mr. T. C. Todd, of Patterson, New Jersey, U.S.A., I have witnessed its performance, and have no doubt it will be universally adopted. It dresses the fibre perfectly, and with a minimum amount of waste." It was patented by Acosta in the United States, in 1892. The chief feature of the Todd machine is its automatic character. The leaves are only handled once, and are cleaned by two drums or scutching wheels working on alternate sides. They are fed in at one end, and the cleaned fibre is delivered at the other. There is no necessity for holding the leaves at any time. A boy can arrange them on the feeding table, and once that is done, they pass into the machine, and the cleaning proceeds automatically. The machine is of considerable size and weight, and is rather costly—about £600. There can be no doubt of its superiority over the raspador. The Todd machines I saw in regular working in the Bahamas were regarded by the planters as fully meeting their requirements. The operator seats himself before the feed table and lays the leaves closely together without overlapping. The points are arranged towards the left hand. The leaves pass into the machine sideways, not endways, as in the raspador. About one-half of each leaf hangs down loosely to the left. The leaf is, first of all, taken up by the feeding belts, and by the latter presented to the first scutching wheel, which cleans about one-half from the point downwards. By a clever interchange of jointed belts passing between the two wheels, the cleaned portion is securely held while the remainder is cleaned by the second wheel. There is no uncleaned or partially-cleaned portion left in the middle; the fibre is delivered entirely free from pith and perfectly straight.

The following account of the Todd machin was published in the *Nassau Guardian*, Jun 9th, 1894:—

"We would remark that Mr. Todd was fortunat in having his machine placed on Messrs. Clough an Menendez's farm, the location and surroundings o which are so favourable for the exhibition of it working powers. An English 5 horse-power engin was used to work the machine, and upon the leave ready for cleaning, being placed in position, the were run through in the simplest manner, coming ou at the opposite end perfectly clean. The attendanc necessary can be performed by one woman or boy t feed, and another to receive the fibre as it is delivere It is claimed that from forty to sixty leaves pe minute can be cleaned, which would yield a goo per-centage of fibre, and if steadily worked at lea 1,500 lbs. could be turned out a day. From all th came under our observation during the time we sa the machine working, we conclude that there nee not be any further delay in the extraction of fibre o account of the absence of improved machinery."

In July following, Messrs. Clough an Menendez reported as follows:—

"At the end of a month's steady work we a pleased to report continued satisfaction with the fib machine. It does its work easily and excellentl It requires comparatively little motive power, ar two women or boys are sufficient to feed in leav and receive the fibre. It certainly is the best fibr extracting machine we have seen, and as far as v can judge it is at least equal to any now in use an where. We believe it will be used by all hem growers here."

The latest published account is from Messr J. S. Johnson and Company, as follows:—

"After twelve months' experience, we are satisfi that the machine, properly handled, is capable producing a ton of fibre in a day of ten hours. V have made 700 bales since we started cleaning, ar with all the interference of weather, and want experience and changes, imperfections of belt, & have averaged over half a ton per day right on for months. I am quite sure that you will soon hear a ton a day, now that the gearing has been improv by making it cog-wheel instead of leather be Finally, let me tell you what I did in October of t year. I arrived at my plantation with a schoo having on board a Todd machine, an engine, boil shafting, pulleys, and baling press, with nothing b the naked ground before me. I arrived on Wedn day afternoon, and on the Saturday following I beg o clean fibre. It took me only two days to put the hole business in operation. It is to day working ke a charm."

It is evident from these accounts, based on ontinuous working over a lengthened period, hat there is no difficulty in cleaning the fibre n the Bahamas. Besides the Todd machine, ere are other machines, such as the Villa-ore, very highly recommended, and perhaps ot so costly. I was not able to see any of ese in actual working during my visit.

The power used for the machines is always team; water-power is not available; and ind-power is too uncertain. An outfit, to rn out about half to three-quarters of a ton f clean fibre per day, would consist of a eam-engine using, preferably, kerosene oil, ot coal, a single Todd machine, and a steam ress. The whole would cost about £1,000. a second machine were added, the total ost would be £1,600, and the output at least ton and a half of fibre per day.

The fibres of Agaves, as indeed of all the ndogenous plants associated with them, are erfectly white if cleaned without fermenta-on. They are, however, easily discoloured, nd not only so, but are considerably weakened the decomposition of the mucilaginous and ccharine matters associated with them in e fresh leaves. Hence it is of the highest nportance that the fibres should be extracted om the leaves immediately they are har-ested. In fact, it may be laid down as a rdinal maxim that Agave leaves must be eaned within a few hours of their being vered from the parent plant. The resulting re, if intrinsically of good quality, will then white and glossy, with the individual fila-ents straight and untangled. When Agave aves are allowed to lie exposed to the sun d air after being cut, they lose the natural oisture, which is useful in cleaning them, d the juices set up a fermentation which, if ntinued long, will seriously affect the quality the fibre. A practical rule for the working a Sisal plantation would be, that the leaves t in the morning should be cleaned the same y, and that the leaves cut in the afternoon ould be put in hand the first thing the next orning.

DRYING AND BALING.

After passing through the machine, the re is hung out to dry in the sun. Too rapid ying is not desirable, as thereby the fibre is t sufficiently bleached. It retains a raw eenish tint which is undesirable. This tint disappears if the fibre is spread out in shade for a day or two before baling. The fibre should not be exposed to night dews or rain, otherwise it loses its lustre and is rendered unattractive. Mixed or badly-cleaned fibre, or that which is stained or dirty, should be placed on one side and used locally. It is not worth exporting except as tow. In Yucatan, "the bands put on bales are made by farm hands, who are paid from 25 cents to 50 cents daily. Each bale requires from 100 feet to 120 feet of rope, weighing from 3½ to 5 lbs. for each bale. According to size and weight of each bale, from four bands to six bands are put on each. The cost of bands is about five cents each. The bales are sold including the weight of bands, these being usually made of the inferior grades of fibres." The bales weigh from 350 to 400 lbs. The cubic measurement is from 20 to 22 feet.

WASTE MATERIALS.

As regards the pulp and watery juices yielded during the process of extracting the fibre these are apparently of no great value. The juice of Agaves is evaporated in some countries to make a soap for cleansing metal utensils. The pulp contains potash. After being well rotted or burnt it would form a useful manure for pine-apples or for the Agave plants themselves. The fine pith thrown out by the machines is very inflammable when dry. On that account it should not be allowed to accumulate in and around the sheds. If a sufficiently large quantity of clean pith could be collected it might be used as a packing material. It is very light, elastic, and, when thoroughly dried in the sun, is free from smell.

YIELD.

In Yucatan the yield of fibre, as a general rule, is 50 lbs. from every 1,000 leaves, "but there are leaves which give up to 100 lbs. per 1,000; this, however, is exceptional. From the fifth to the seventh year the average yield of good plants is 75 lbs. per 1,000 leaves."

With 650 plants to the acre, each yielding 33 leaves containing at the rate of 60 lbs. of fibre to the thousand leaves, we would have a total yearly yield of 1,200 lbs. or a little over half a ton per acre. This is the usual return in Yucatan. In the Bahamas with closer planting and more improvod machinery it it likely to be higher. It is not likely in any case to fall below half a ton. It may be as high as three-quarters of a ton per acre. If we take the lower estimate of half a ton to the acre, costing for production 1d. per lb., and realising the very low price of 1½d. per lb. (the lowest ever known for Sisal fibre) there would still be left a margin for profit of ½d. per lb., or £4 10s. per acre. It is believed that the total cost of cutting, carting, and cleaning the leaves, of baling the fibre, and placing it in the New York market, need not exceed £9 to £10 per ton. In any case, the work of the plantation should be strictly regulated to meet these requirements. Anything beyond this should be regarded as excessive and unjustifiable.

In Yucatan, the "planter estimates his crop to cost for cultivating, cutting, cleaning, baling, and marketing, 2½ to 3 cents per lb. At the price of fibre (in 1891) of 5 cents per lb., and taking 3 cents as the cost of production, an acre yielding 1,287 lbs. would give a net profit of 25 dollars." As these are Mexican dollars, the profit in Yucatan is less than that estimated for the Bahamas.

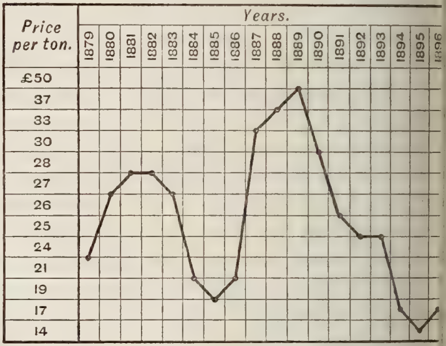
FREIGHT.

As to the best outlets for Bahamas Sisal, there is no doubt that the chief market, at present, is in the United States of America. The ports of New York, Boston, and Philadelphia take fully 90 per cent. of the production of Yucatan; the United Kingdom takes about 5 per cent., while the balance is divided between Cuba, Germany, France, and Spain. The rates of freight from the Port of Progresso to the United States vary from $\frac{3}{16}$ cents, ¼ cents, to $\frac{5}{16}$ cents per lb., plus 5 per cent.

The rates of freight from the Bahamas to the United States ports should be lower than from Progresso. The actual distance is less than one half. At first they will probably be more, but as the trade increases it will be possible to charter schooners to deliver the fibre at such advantageous rates as will compete successfully with any freight rates in force at Progresso. There is an export duty levied on Sisal at Progresso at the rate of $\frac{1}{16}$ of a cent. per lb. This amounts to about 6s. per ton. This would be additional to the freight charged. A remarkable instance of low freights was quoted in Willett and Gray's circular of January last. The charter of a ship of 1,575 tons from the Philippine Islands to the United States was reported, for Manila hemp, at $5·50 per ton. This was for a distance of 15,000 miles!

FLUCTUATION IN PRICES.

In 1888 and 1889, owing to the formation of the National Cordage Trust in the Unite States and the efforts made to control th entire supply of white-rope fibres, the price Sisal was extraordinarily high. This was purely artificial state of things and had n reference to the ordinary market value of th fibre. The average price in 1887 was £33 p ton. In the beginning of 1888 it rose £36 10s., but towards its close, owing to th action of the Cordage Trust, it went up to £4 per ton. In January, 1889, it reached £50 p ton. This was unprecedented; but in Marc of that year it went higher still and reached maximum of £56 10s. per ton. At this pric two bales of Bahamas Sisal happened to b sold in the London market. The fact wa hailed as a proof of the great intrinsic value the fibre and attracted attention all over th world. This circumstance really did harm the prospects of the industry as it stimulate over-production in Yucatan. The two bal



in question were bought at this fancy pri for a special purpose, viz., for making ladie hats and bonnets. The consumption for th is so trivial as to be hardly worthy of notic Soon after the Cordage Trust came to gr causing serious loss, if not ruin, to a lar number of people in the States. The lar stock of fibre held by it coming suddenly the market prices fell so rapidly that at t end of 1880 good fair fibre was sold at £27 10 per ton. In 1891 it was further reduced £23 10s, in 1893 to £20, in 1894 to £15, un in July, 1895, it reached the lowest price it h ever reached. This was £13 per ton, or little less than 1½d. per lb. Since th time it has slightly improved. During t current month (March, 1896), it is quoted Messrs. Ide and Christie's circular at £17 £17 10s. per ton. The violent fluctuations Sisal during the last 17 years may be gather from the above diagram showing the avera rice per ton of fair quality Sisal hemp in the ondon and Liverpool markets from 1879 to 895 (inclusive). I am indebted for the material r constructing this diagram to Messrs. Ide nd Christie, fibre brokers, 72, Mark-ane, E.C.

SUMMARY.

The Sisal industry in the Bahamas is now in fair way of being established. It has had to ass through several very trying experiences, ut the ultimate issue is decidedly promising. he efforts to start any new branch of industry re laborious, and often costly. The first stimates of expenses are usually placed too w, and the returns too high. For a year or vo things look hopeful; then there is a period f suspense and uncertainty; with a fall in rices a reaction sets in, and the cultivation is ther relaxed, or probably abandoned. In me, however, if steadily and intelligently pur- ued, the profits, though smaller than antici- ated, are often of a substantial character. he Bahamas Sisal has successfully passed rough these stages. Those engaged in it re now hopeful of its ultimate success. They el that, by keeping down the expenses to the west, they will always have a margin for rofit, with the possibility that, on an average years, the returns will fully reward their bours. It is estimated that about 100,000 res of Crown land have been disposed of for re purposes, and possibly there are 15,000 res of private lands also set apart for the me purpose. These areas will practically present the outside limit of Sisal cultivation the Bahamas. The actual area so far anted is probably not more than 25,000 res. Of this, about 12,000 acres are likely yield fibre within the next two years. At e end of 1897 the exports should reach about 000 tons. Bahamas Sisal will, therefore, not me immediately into serious competition th any other white-rope fibre. These facts ll afford commercial men, both here and in e States, the means of forecasting, with lerable accuracy, the future of the industry.

The chief points to which attention should w be directed are the uniform production first-class fibre—that is, fibre of good lour, lustre, and strength—to meet the re- uirements of the best markets. If necessary, gislative action should be adopted, to safe- ard the interests of the industry, and prevent ort, inferior, or immature fibre from being ipped from the colony. The fibre is at its st only after due time has been given for its growth; and hence unwise methods should be dealt with by the Government in the highest interests of those who have embarked their capital in the enterprise, as well as of those who may hereafter take part in it. Consistent efforts should also be made to produce the fibre at the lowest possible cost, so as to leave a margin for profit upon the lowest price at which similar fibre could be produced in any other country.

The practical difficulties connected with starting the industry have been overcome. Labour is both cheap and sufficiently abundant for all present requirements. Experience has shown how best to avoid some of the errors of the past; and given only moderate prices for the produce, the future of the Bahamas Sisal should be as well assured as that of any planting industry. Its success would be of considerable benefit to the Bahama Islands, as it would bring to them such a measure of prosperity that would stimulate the development of many other industries for which they are admirably adapted by their geographical position, and the favourable circumstances of both soil and climate.

At the conclusion of the paper, Dr. Morris described the specimens of fibres from the Bahamas Court at the Imperial Institute, lent by Mr. Washington Eves, C.M.G., and the specimens from Kew-gardens. The paper was illustrated by a series of lantern slides.

DISCUSSION.

Dr. **Morris** said that of all the hundreds of agaves growing in different parts of the world there was no doubt that the Bahamas plant produced the best fibre. Besides ordinary ropes, trays, hats, and other articles were made from the sisal, but the consumption for those purposes was not likely to be very great, and its chief value was for making white rope and twine, for which there was an enormous demand. This Sisal industry connected with a British colony was of great importance. It would be the means of giving new life to the colony, and would enable the people there to start other industries alongside of it. He hoped those who had invested their money in this industry would accept the suggestions he had made in the paper after seeing the plantations in the Bahamas, and carefully considering the circumstances for many years. He first saw the plant in British Honduras in 1882, and read a paper in 1884 at the Town-hall, Kingston, Jamaica, strongly recommending the people of Jamaica to take up the industry. They had not seen their way to doing so, but the people in the Bahamas had, and being favourably placed as regarded soil and climate generally, it was to be hoped they would make a success of it.

Mr. **Barraclough** said there was a slight omission in the valuable paper they had just heard. The best machine for treating the plant was really invented by a Mexican, named Prieto, 17 years ago. His representatives forgot to renew the patent after his death, and it was now public property. The machine had little chains and drums, as in Todd's machine, which was really adapted from the idea of another Mexican, named Acosta.

Mr. **Herman Lescher** (Bahamas Fibre Company) wished to add his testimony, as chairman of the principal company in London connected with this industry, to the great advance the industry had made. His company had had five years' experience from the reports of its agents, as to the growth of the plant and the industry generally, and he was bound to say that a more accurate recapitulation of the experience they had had than that contained in the paper he had not heard. This industry, like all others, required the capital, pluck, and enterprise of the English people; and he was glad to say that capital and enterprise had been supplied by three or four very influential syndicates. As chairman of the chief of these, he could speak of the encouragement and assistance which must be derived by the industry from the circulation of the valuable paper.

Admiral **Fane** said he had intended to ask some questions, and to make a few remarks upon the subject, but he had been forestalled by the reader of the paper, to whom he could only offer his thanks for his very able paper they had just listened to.

Dr. **Morris** said he was not aware of the name of the original inventor of the so-called Todd machine. He made careful inquiry about it in the United States, and was told that the machine was patented there by Mr. Acosta; but he was pleased to know that the remarks made with regard to the claims of Prieto would be placed on record in the Society's *Journal*. It was very proper that Prieto's name should appear in connection with a machine which had been of great value to all fibre-growing companies, for it was too often the case that the names of first inventors and pioneers were forgotten. He had presented this paper before an English audience for the purpose of showing what Englishmen were doing in a remote part of our possessions. We had possessions distributed all over the globe, and wherever the traveller went he always found that the people were as much attached and as loyal to the mother country as those at home. That was not a mere matter of sentiment, but was the real feeling of the people, and they acted upon it. Not a single ship left England for the Bahamas; and all their commerce went through the United States, and yet the people there were as loyal to the mother country as they could possibly be. Apart, therefore, from the investment of capital, Englishmen would be glad to hear an account of an industry which had been started in the Bahamas, and to know also that although it had fallen on evil times as regarded prices it had yet the prospect of a good time before it, and that the people out there were thoroughly satisfied that the return upon the capital invested would be substantial.

The **Chairman** proposed a hearty vote thanks to Dr. Morris for his valuable paper and illustrations They were all glad to hear of the loyalty existing in our colonies. Dr. Morris had visited many of th colonies and reported upon their botanical productions, besides residing for several years in Jamaica a head of the Plantation Department there. In tha colony the feeling of loyalty was very strong, and th people felt no desire to separate from the mothe country or to become subjects of the great republi which was so close to them. That was generally th case throughout our colonies, where the feeling o loyalty was even more demonstrative than in th mother country. If we should at any time be involved in war with other nations, our fellow subject in the colonies, white and black, would all ban together, and would be prepared to fight in defenc of the Empire.

Dr. **Morris**, in acknowledging the vote of thank said that he felt greatly honoured by the presence o Sir Henry Norman in the chair. Sir Henry wa Governor of Jamaica at a time when the islan industries required a good deal of encourageme for their development. He took the greatest intere in them, and Jamaica was during his time one the most prosperous colonies in the possession the British Crown.

Miscellaneous.

HORSE AND HORSELESS CARRIAGE AN ROADS LOCOMOTION EXHIBITION, 18

A meeting of the Honorary Council of the Ho and Horseless Carriage and Roads Locomoti Exhibition, to be opened at the Crystal Palace May, 1896, was held at the Mansion-house, Friday, 6th inst.

The Right Hon. the Lord Mayor of Lond (Master of the Worshipful Company of Coa Makers and Coach and Harness Makers) was in t chair, who expressed his pleasure as Lord Mayor a Master of the Coach Makers' Company, to welco those present for the purpose of discussing a arranging an exhibition likely to be of interest a profit to the craft.

Mr. William Gardiner, Secretary of the Crystal alace, made the following statement:—"There xists at the moment in this country an industry—hat of the manufacture of self-propelling vehicles or use upon the common roads—which is scarcely et beyond its nascent condition, but which is far nore advanced, and indeed has asssumed considerble magnitude, in other countries, and in regard to vhich proper publicity and demonstration cannot be iven in this country under existing legislation, except n extensive private grounds such as those attached o the Crystal Palace. Under these circumstances nanufacturers have again looked to this institution, nd in response the Directors have much pleasure in nnouncing that an Exhibition of a comprehensive nd international character of all things appertaining o the road, to travel, and to mechanical roads locootion, is to be opened in May next. It has been epresented to the Directors that if, concurrently vith the exhibition and demonstration of the most odern applications of science to mechanical locootion upon common roads, an Exhibition of all inds of animal-drawn road vehicles and carriages of oth historical and current interest be held, including lustrations of ancient modes of travel, and of road onveyances now displaced by the introduction of ilways, great commercial, educational, and recreave advantages would accrue. Thus encouraged and ided by the practical assistance of the City comanies, the Worshipful Company of Coachmakers, e Institute of British Carriage Manufacturers, as ell as private owners, who are lending their valuble and unique collections, the Directors intend to rry out this universally expressed desire to the reatest extent the space at their disposal—and this great—will admit."

Sir David Lionel Salomons, Bart., said—There are few living amongst us who can probably remember e first move in what may be termed horseless affic. It would be going back a great number of ars to the time when Gurney, Hancock, and others arted this mode of locomotion, against whom railays for a time set up the wall of a strenuous opposition. Even as far back as 1836, it is on record that Parliamentary Committee sat, and declared itself rongly in favour of this mode of locomotion, which d not demand the capital that was necessary to lay ils for trucks and waggons to pass upon. From at date—some time in the thirties—till quite rently, nothing has been heard of this mode of locootion, although isolated engines have appeared from ne to time on the roads—partly as experiments to nuse individuals, and partly as attempts to bring em again before the public. In any case, they iled; and it was not till 1865 that there was any ove in this direction, and then it was in regard to avy traffic and the traction engine, with which we e not at this time proposing to deal. In 1865, an ct was passed, to get rid of the nuisance which it as supposed would be introduced by these locootives appearing upon London roads; and in 1881, due to a clumsy wording of the Act which was in 1878 passed to amend the Act of 1865, a decision against the use of a small steam tricycle settled the question of light-propelled traffic from that time to this, it having been declared virtually by the Judges—and probably rightly, on the interpretation of the Act—that such a vehicle was a locomotive within the meaning of the Act. This revival—for after all it is but a revival—of this mode of traffic which has interested us so much of late, was started by the French last year by their races. The English racecourse has improved our breed of horses, and the racing of these carriages will certainly improve the breed of motor cars.

Speeches were subsequently made by Mr. Vaughan Pendred, Major S. Flood-Page, Professor Hughes, Mr. A. K. Sennett, Mr. George Hooper, and others.

The Exhibition will be divided into 12 Sections, which are again subdivided into Classes:—Section 1 (Classes A, B, and D). Fine art, literature, sculpture, antiques and curios, and illustrations of primitive modes of travel. Section 2 (Classes B and E). Ancient and modern harness. Section 3 (Classes C and D). Ancient and mediæval carriages. Section 4 (Class D). Ancient and modern carriage of the mails. Section 5 (Classes E, K, L, P, and Z). Accessories to modern travel and sport. Section 6 (Classes G and H). Coaching. Section 7 (Classes F, G, and H). Modern carriages. Section 8 (Classes H, J, and Z). Modern transport. Section 9 (Class Y). Military and cycle transport. Section 10 (Classes M, N, O, W, and X). Material, plant, and machinery. Section 11 (Classes Q, U, V, and Y). Mechanical road locomotion. Section 12 (Classes R, S, and T). Horseless carriages. In this section will be included every kind of self-propelled passenger vehicle, these being shown in action in the extensive grounds, and at a later date competitions as to speed and general efficiency in actual work will be carried out. Facilities will also be given to exhibitors who may desire to show their motors in actual operation in boats and launches upon the lakes and basins.

ANTARCTIC EXPEDITIONS.

Mr. T. Gilbert Bowick, Chairman of the Executive Committee for the British Antarctic Expedition, 1896, has put forth an appeal for support. This expedition will consist of English-trained scientists, and will be equipped with the necessary huts, dogs, sledges, ski, &c. They will remain one year in South Victoria Land.

The following is a general plan of the proposed investigations:—1. A land party will work towards the South Magnetic Pole, there to make magnetical observations. 2. The coast-line of the open bay will be surveyed; fjords and bays explored and sounded. 3. Zoological, botanical, mineralogical and geological collections will be made. 4. Dredging.

5. Barometrical, thermometrical, meteorological and pendulum observations. 6. Air and water current obsevations.

Magnetical observations in the South are at present not only urgently required for the purposes of navigation, but also for supplying a missing link in our knowledge of terrestrial magnetism.

The results of the last Antarctic Expedition (1893-1894) have been fully recognised by the leaders of the International Geographical Congress held in London a few months ago, and found expression in the following resolution:—"That the sixth Geographical Congress assembled at London, 1895, records, with reference to the exploration of the Antarctic regions, its opinion that this is the greatest piece of geographical exploration still to be undertaken, and in view of the addition to knowledge in almost every branch of science which would result from such a scientific exploration, the Congress recommends that the several scientific societies throughout the world should urge, in whatever way seems to them most effective, that this work should be undertaken before the close of the century."

A commercial expedition is being formed with the object of operating near Victoria Land, and the leaders have declared themselves willing to co-operate with a scientific expedition, in so far that they will convey the scientific members down to Cape Adair, and land them there, with their appliances, instruments, and stores, and also undertake to go down the succeeding spring to bring them back. The time has therefore arrived to apply to those interested in Antarctic discoveries to come forward and enable science to benefit by this opportunity.

The outfit and supplies for twelve scientific men to spend a year in Victoria Land will, including the voyage down and back, cost about £5,000.

The expedition will consist of a whaler of about 300 tons, and a small steamer of about 70 tons. The scientific party will comprise twelve specialists, who will be selected by the council. Already applications are pouring in from all parts of the United Kingdom. The party is supposed to leave on September 1st next. After calling at Melbourne, they will sail direct to Cape Adair, which, under favourable circumstances, should be reached in about fourteen days. There they will be landed with their outfit and instruments, and remain for one year. Provisions for a considerable longer period will, however, be taken ashore. After landing the scientific members of the exhibition on about November 20th at Cape Adair, the commercial party will devote themselves to securing the black whale, blue whale, and seals, which are extremely plentiful. They will leave South Victoria Land for Melbourne about the middle of February, with a cargo for Melbourne. After discharging they will drop down to the neighbourhood of the Campbell Islands for fur seals and black and sperm whales. At least three trips should be made by December 15th, when the expedition will again be ready to leave Melbourne for Cape Adair. On arrival at South Victoria Land they will operate for whales and seals for a month, take on board the scientific party with their collections and effects, and arrive in Melbourne by the middle of February, 1897

Since Sir James Ross, in 1841, discovered th South Victoria Continent, no one had visited thos southern shores until last year, when the steam whaler *Antarctic* ran into that large ice-free ba which stretches from Cape Adair down to the Vol canoes, the Erebus and the Terror.

Cook, Weddell, and Ross, were the only navigators who had crossed the seventieth parallel befor the 1894 Commercial Expedition; they had see the ice-pack, but had never passed through i Captain Cook reached its edge in 71° 10′ S., and i 1823 Captain Weddell had the extraordinary goo fortune to attain a latitude of 74° 15′ S.. withou meeting it.

A Belgian Scientific Antarctic Expedition has als been arranged under the superintendence of a committee of the Société Royal Belge de Géographi It is expected that a sum of £10,000 (250,000 franc will be required for the complete expense of th enterprise.

Correspondence.

REPORT OF THE ROYAL COMMISSIO ON SECONDARY EDUCATION.

I have but just seen in the Society's *Journal* f March 6th, Mr. Macan's statement that he had be informed that I should "very likely" be present his lecture at the Society of Arts on February 21, which he criticised the position I took up on t secondary education question. This seems to me that some friend, qualified to speak for me, had be repeating what I had said. This is not the ca Neither myself nor (so far as I know) anyone el whose views Mr. Macan found fault with, had a inkling of the line he intended to take; and I cann therefore hold he is justified in saying he "took necessary precautions to secure the presence persons competent to answer" him.

J. T. THORNTON.

PEASANT LIFE AND INDUSTRIES I IRELAND.

I fear that one sentence in the report of my pa in the last number of the *Journal* may cause so slight misconception. I refer to the words "but small light curraghs are not suited for the devel ment of this [the fishing] industry, although th are a useful craft in many ways" (p. 390). I afraid that I was not sufficiently explicit. Th canvas canoes are certainly not suited for develop a fishing industry on a large scale without the ass ce of larger vessels, and they can only be used for ne-fishing and seining ; trawling is impossible with em. The curraghs are a valuable class of boat for e rough waters off the western seabord, as, in dition to their seaworthy quality, to which I drew ecial attention, and the facility with which they n be beached, they are comparatively cheap, and e thus eminently fitted for small fishermen. By nploying their canoes as tenders to larger craft, and y supplying the curing stations with fish, the small shermen can make this kind of fishing pay.

A. C. HADDON.

Obituary.

JAMES ABERNETHY, M.Inst.C.E.—Mr. Aber- thy, the eminent civil engineer, who died on unday, the 8th inst., at his residence, Whiteness, roadstairs, aged 81 years, was elected a member of e Society of Arts in 1858. He was President of e Institution of Civil Engineers in 1881, and livered his presidential address on the 11th of nuary of that year. His long experience and skill a designer and constructor of docks and harbours, d other marine engineering works, extending over period of sixty years, won for him the title of Father of Marine Engineering." Born at Aber- en on 12th June, 1814, he became, at an early age, assistant to his father, the late Mr. George Aber- thy, M.Inst.M.E., during the construction of the art Point Docks, and other similar small works, d in 1844, at the age of 28, was appointed gineer-in-chief, and entrusted with the design and nstruction of the Aberdeen Docks, and since that riod he has been steadily engaged upon, or con- lted in connection with many harbours and ports in e United Kingdom and abroad. Among a few of ch works which bear testimony to his eminence as hydraulic engineer may be mentioned Swansea 847 and 1881), Birkenhead (1851-58), Silloth 856-59), Newport (1856 and 1876), Falmouth 858-61), Alexander Dock, Hull (1881), and Bute ocks, Cardiff (1887); but his name is, perhaps, st remembered at the present time from his having en Consulting Engineer to the Manchester Ship nal Company (Sir E. Leader Williams being gineer-in-Chief) between the years 1888 and 92. At the time of his death, Mr. Abernethy, th the assistance of his two elder sons, whom he ok into partnership in 1892, and who have been for ny years associated with him in his business, was gaged in the important work of deepening and tending the harbour of Fraserburgh in Scotland, th which he first became professionally connected 1856. He served on two important Royal Com- ssions, viz., Metropolitan Sewage Discharge, in 82, and Irish Public Works, 1886. In 1888, the King of the Belgians conferred on him the Order of Commander of Leopold in recognition of his services as member of a jury appointed to report upon the construction of harbours and sandy coasts. Mr. Abernethy had for some years past been a Justice of the Peace for the counties of Kent and Middlesex. He married, in 1838, Anne, eldest daughter of the late John Neill, Esq., of Leeds, who survives him after an exceptionally long married life of 58 years.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

MARCH 25.—"Our Food Supply, as affected by the Farming of the Future." By PROF. JAMES LONG.

Papers for meetings after Easter :—

"Early English Organ Writers." By BURNHAM HORNER.

"The Perfected Photochromoscope and its Colour Photographs." By F. E. IVES.

"Fruit Drying or Evaporation." By EDWARD W. BADGER.

"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

"High Explosives and Smokeless Powders." By HUDSON MAXIM.

"Tunnelling by Compressed Air." By E. W. MOIR.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Half-past Eight o'clock :—

MARCH 26, at 8.30.—"Kashmir : its People and its Products." By WALTER R. LAWRENCE, I.C.S., C.I.E. The EARL OF DUNMORE will preside.

APRIL 23, at 4.30.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14, at 4.30.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of April 23, and May 14 will be held at the Society of Arts; that of March 26 at the Imperial Institute.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

The meeting announced for April 14th will not be held.

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified:—

The meeting announced for April 21st will not be held, and Captain Pasfield Oliver's paper on "Madagascar," announced for that date, is unavoidably postponed, owing to the illness of the author.

MARCH 24.—"The Colonies and the Supply of Dairy Produce and Products of Petite Culture." By CHARLES R. VALENTINE. SIR WESTBY B. PERCEVAL, K.C.M.G., will preside.

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

H. GRAHAM HARRIS'S Cantor Lectures on "Refrigeration," announced for delivery on March 9, 16, and 24, are unavoidably postponed.

HENRY A. MIERS, M A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 23...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Dr. R. Milne Murray—(i.) "A Simple Ammeter suitable for Lamp Testing;" (ii.) "A Water Manometer for Recording Minute Variations of Pressure." 2. Mr. Alex. Fraser, "Recent Improvements on Microtomes."

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. Bowdler Sharpe, "The Migration of Birds."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, MARCH 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Charles R. Valentine, "The Colonies and the Supply of Dairy Produce and Products of Petite Culture."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The External Covering of Plants and Animals: its Structure and Functions." (Lecture XI.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Captain H. Riall Sankey, "The Thermal Efficiency of Steam-engines."

Photographic, 12, Hanover-square, W., 8 p.m Mr. F. S. Ives, "The Relative Colour Sensitiveness of Ordinary and Isochromatic Plates," with demonstration.

Imperial Institute, South Kensington, S.W., 8½ p.m Mr. A. Patchett Martin, "The Beginnings of a Australian Literature."

WEDNESDAY, MARCH 25...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Prof. James Long, "Ou Food Supply, as Affected by the Farming of th Future."

Naval Architects (at the HOUSE OF THE SOCIETY o ARTS). Annual Conference, 11 a.m. 1. Address b the Chairman, the Earl of Hopetoun. 2. Captai the Right Hon. Lord Charles Beresford, "Water tight Doors, and Their Danger to Modern Fightin Ships." 3. Colonel Nabor Soliani, "Watertigl Doors." 4. Mr. J. G. Bruhn, "Some Geometry i Connection with the Stability of Ships."

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 20, Hanover-square W., 8½ p.m. Mr. James Curtis, "An Anthology Hudibras."

THURSDAY, MARCH 26...SOCIETY OF ARTS (at tl Imperial Institute, South Kensington, S.W.), p.m. (Indian Section.) Mr. Walter R. Lawrenc "Kashmir: its People and its Products."

Antiquaries, Burlington-house, W., 8½ p.m.

Civil and Mechanical Engineers, 45, Charing-cros S.W., 7 p.m. Mr. A. A. Myall, "Wire Nettir Machinery."

Chemical, Burlington-house, W., 8 p.m. Annu Meeting. Presidential Address.

Royal Institution, Albemarle-street, W., 3 p.m. Re William Barry, "Masters of Modern Thought (Lecture IV.—Spinoza.)

Electrical Engineers, 25, Great George-street, S.W 8 p.m. Mr. D. Sinclair, "Telephone Exchang and their Working."

Naval Architects (at the HOUSE OF THE SOCIETY ARTS). Annual Conference. 12 o'clock. 1. M A. E. Seaton, "The Causes of Mysterious Fra tures in the Steel used by Marine Engineers Revealed by the Microscope." 2. Mr. C. Stromeyer, "The Measurement of Feed and Ci culating Water, &c., by Chemical Means." Mr. J. G. Kinghorn, "Salvage Appliances 7 p.m. 1. Col. Nabor Soliani, "Compou Marine Boilers." 2. Mr. J. Watt, "Water-tu Boilers." 3. Prof. W. H. Watkinson, "Circ lation in Water-tube Boilers."

Camera Club, Charing-cross-road, W.C., 8 p.m.

FRIDAY, MARCH 27...Naval Architects (at the HOUSE THE SOCIETY OF ARTS). Annual Conference, o'clock. 1. Mr. E. Froude, "The Non-unifor Rolling of Ships." 2. Captain A. Kriloff, " New Theory of the Pitching Motion of Ships Waves, and of the Stresses Produced by tl Motion." 3. Mr. George Herbert Little, "No on the Carriage of Grain Cargoes."

Royal Institution, Albemarle-street, W., 8 p. Weekly Meeting, 9 p.m. Professor Dewar, "N Researches on Liquid Air."

Civil Engineers, 25, Great George-street, S.W., p.m. (Students' Meeting.) Mr. Julian S. Wi "Closing a Dock Entrance for Repairs."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science, Chemical Society's Rooms, Bu lington-house, W., 5 p.m.

SATURDAY, MARCH 28...Botanic, Inner Circle, Regent's-pa N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p. Lord Rayleigh, "Light." (Lecture VI.)

Journal of the Society of Arts.

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FRIDAY, MARCH 27, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOREIGN & COLONIAL SECTION.

Tuesday evening, March 24, 1896; Sir Westby B. Perceval, K.C.M.G., in the chair.

The paper read was "The Colonies and the Supply of Dairy Produce and Products of Petite Culture," by Charles R. Valentine.

The paper and discussion will be published in a future number of the *Journal.*

INDIAN SECTION.

Thursday evening, March 26, 1896; the Earl of Dunmore in the chair.

The paper read was "Kashmir: its People and its Products," by Walter R. Lawrence, I.C.S., C.I.E.

The paper and discussion will be published in a future number of the *Journal.*

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 3, 1896; Sir James Crichton Browne, M.D., LL.D., F.R.S., in the chair.

The Chairman, in opening the proceedings, said it was quite unnecessary to introduce Mr. Scott Elliot, as he was already known to the reading public by his interesting and important book. Probably the reason he had been asked to take the chair on this occasion was that he came not only from the same country, but the same county, as Mr. Scott Elliot. When Dean Buckland went down to that county, Dumfriesshire, to examine the geological formations there, he made the observation that the footprints of the antidiluvian animals in the old red sandstone clearly showed all the toes pointing southwards; so that even in those ancient times Scotch animals seemed to have been inclined to travel south. Both himself and Mr. Scott Elliot had come across the border, and the latter had travelled very far south, to Madagascar (from whence he had brought much interesting information), and on other regions of Africa, on which he was to speak to-night. He had, however, returned to his native country, and he (the Chairman) had heard him deliver a most interesting lecture in Dumfriesshire. It was a curious fact that that county had been very productive of explorers. From it came Mungo Park, Richardson, and Joseph Thomson, whose loss they had had so recently to deplore, and others of less renown. In Dumfries they were very proud of the work which Mr. Scott Elliot had done, especially as he had given up the promise of a lucrative mercantile career to devote himself to scientific exploration.

The paper read was—

COMMERCIAL PROSPECTS OF BRITISH CENTRAL AND EAST AFRICA.

By G. Scott Elliot, M.A., F.R.G.S.

The discussion at the Geographical Congress, in July, on the future of Africa, proved very clearly one distinct fact, namely, that all the best authorities hold entirely different views. Some stated that English families can live on the Congo, while others declared that colonisation is nowhere possible in Africa, and that no one has any intention of trying the experiment. This strange diversity of opinion is quite easily explained, for a whole continent cannot possibly be valued at the same rate or developed in the same way. The West Coast, Shiré highlands, and the Masai country, are as different from one another as Nicaraqua, Jamaica, and New York. Our practical knowledge of the interior is extremely modern, and in any new country there is but one test of commerce, that is experience. What may be true of West Africa is entirely false for the Shiré highlands and *vice-versâ.* Therefore, in trying to explain what are the commercial prospects of our African colonies, it is extremely necessary to distinguish clearly those districts which are in climate and probable future essentially distinct. This is most conveniently arranged by taking altitude above the sea as the characteristic. I shall take first those parts of our tropical African sphere which lie below 3,000 feet, then the portion between 3,000 and 5,000 feet, and finally the relatively small extent above 5,000 feet. These levels approximately mark out distinct climates and, therefore, different vegetable products; but they also most nearly separate the three distinct ways in which new countries are commercially valuable. Below 3,000 feet we have a country rich in native products, or as Mr. Scott Keltie calls them, "jungle products," *i.e.*, produce which is either natural to the jungle, or does not involve careful plantation by Europeans.

Between 3,000 and 5,000 feet is the area in which tropical plantation is mainly carried on, while above 5,000 feet we find a country very poor in native products, not apparently of proved utility for plantation, but possibly a field for colonisation, which is, of course, very different to temporary settlement for plantation.

Of the authorities consulted, I have found the works of Speke, Buchanan, C. T. Wilson, Captain Lugard, and Mr. Scott Keltie the most valuable, and am very glad to be able to thank them. My own part has been chiefly to judge from the natural vegetation, as a botanical explorer, whether two different districts in Africa have somewhat the same prospects or not; but it is essential to remember that only the result of practical experience is of real permanent value, and this I have tried to collect from all sources.

AREA OF NATIVE PRODUCTS.

I shall first take Africa below 3,000 feet, in which Europeans have had experience since the year 1618. The Zambesi and Shiré valleys, as well as much of the plain round Nyassa, are below this altitude. It may be described as a broad alluvial valley, which, in the rains, becomes an impassable marsh, but at other seasons is covered by dry, withered grass, varied by patches of trees. Round Lake Nyassa and in a few other places, the sides of this wide alluvial valley are clothed by dense, hot, steamy forests, such as we find in the Congo and Niger basins. In these woods are valuable native products, such as the rubbervine, strophanthus, kulawood (a new dye, similar to camwood, found on Tanganyika), and the oil palm. The amount and character of these rubbervines is not known (Mr. A. D. Whyte points out four species as found, or likely to be found), but the area of these dense hot forests is so small that it is scarcely likely that, unless the Landolphia is cultivated, the export will be large.

The oil palm exists on Nyassa and Tanganyika, chiefly in German territory; it prefers moist soil in warm deep valleys, begins to bear in four years (the maximum yield[*] after 15 years), and remains fruitful for 60 years. Therefore, as the price is about £20 per ton, and the plant requires no cultivation except mere planting, this is a hopeful article of export. Another native plant, the cocoanut palm, is equally promising. In German East Africa there are large and increasing plantations of this tree, and it is known to grow in India up to 3,000 feet within 150 to 200 miles of the sea, and on similar soil to that found on the Zambesi. This yields in five years (100 nuts a year), and remains in bearing 70 to 80 years. Besides these native products, there is direct proof that some plantations can be carried on in spite of the climate, which is hot, moist, and depressing, with fever of a bad type quite commonly prevalent. Thus there is a flourishing sugar factory on the Zambesi, and Mr. Buchanan has also proved that this can be produced on the upper Shiré at Liwonde. Cotton is also produced, and there is certainly plenty of rich clayey alluvium which ought to be adapted to this plant. It must not be forgotten, however, that cotton is supposed to require a certain proportion of calcareous matter, and in German East Africa several plantations have been abandoned as unprofitable, and replanted with cocoanut or coffee. There are other substances which are regarded by Messrs. Buchanan and Whyte as "sure articles of commerce," of which I shall mention sesame (beniseed), rice, the groundnut, and castor oil. The value of these articles is, however, scarcely so high that the cultivation may be safely recommended. Of unproven plants there are the cocoa tree (*Theobroma cacao*), which has been a great success in the German Cameroons (where 120,000 kilogrammes were exported last year), but this is always a delicate and difficult thing to grow, and if I am correct in supposing that it requires forest leaf-mould and plenty of shade it is not probable that it will be much cultivated on these broad alluvials. The caoutchoucs (*Manihot Glaziovii* and *Hevea Brasiliensis*) have also been suggested, but these plants take so long to mature, and the yield appears so small per tree that it is doubtful whether they will be a success. Vanilla has been so far profitable in German East Africa. It should be planted at the foot of shade trees in pretty moist clay soil, at about 1,000 feet altitude (as in Vera Cruz). It is worth some 19 francs a lb., but is difficult to prepare and grow, as it requires artificial pollination and certain manipulations in drying which are not easy. There are only two plants which have failed utterly: opium in the Zambesi, and the nutmeg in German East Africa. I should be inclined to recommend the indigo plant and the cultivation of Landolphia vines as distinctly promising.

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[*] Average yield 1-3 gallons per tree.

The rubber now used in commerce is almost entirely derived from the jungle of tropical forests, and is therefore certain to diminish in amount. It is almost invariably gathered by natives, who adopt the most destructive methods, as these give them the least trouble. Therefore, as the demand is now increasing, and the supply is diminishing, it is perhaps the most important problem in commercial botany to find what plants can be cultivated profitably. The experience of Hevea, Manihot, and the india-rubber fig is not satisfactory, as, so far, the yield in the old world is not sufficient for practical planters to undertake their cultivation. I do not know why gutta-percha has not, to my knowledge, been tried in British Central Africa, but this, and an experimental trial of Landolphia, is most desirable. As a suggestion, I should recommend that the latter should be cultivated somewhat after the same general plan as is found most useful with vanilla. The vines should be placed in the natural bush, choosing a moist place, where ferns are numerous. The ground should be cleared for a circle of 10 feet radius round each tree, and each vine allowed to grow round the stem. Wholesale cutting down of the large trees is probably a mistake, as it involves needless expense. The plan that has been adopted in some places on the West Coast of setting native convicts and prisoners to plant oil palms in convenient and suitable spots on behalf of Government would probably be found a great success, as, after 10 years, very large and lucrative Government plantations would result from this.

Thus in British Central Africa, below 3,000 feet, there are considerable native products, and a wide series of possible articles of export derived from plantation. The country may, indeed, be safely regarded as a sort of small Ganges valley capable of producing many valuable plants and supporting an enormous population, but unsuitable for Europeans.

In English East Africa, below 3,000 feet, there are many river valleys which do not contain much broad alluvium, but are fairly moist, and with considerable patches of rich humus soil. These valleys occupy a small proportion of the total area, which is, for the most part, occupied by a continuation of the dry vegetation of Somaliland, characterised by thorny acacias, fleshy euphorbias, and the sanseviera plant (which furnishes "bowstring hemp"). The natural products of the valleys may be considered as similar to that of the Zambesi, viz., rubber and cocoanut palms; those of the ridges and plains are as yet untested, but gum copal (worth £7 to £8 per cwt.) and orchilla may be expected. It may be possible to obtain a satisfactory rubber from the fleshy euphorbias, which are exceedingly common. A sample which Mr. Watson sent home for me is said by Mr. T. Christy to show good elastic properties, but the milky juice of these plants is usually mixed with resins, and is at present only employed for adulteration. A company was formed to produce paint from this juice, which is said to be a safeguard against the growth of barnacles on ships. The enormous numbers of sanseviera plants may, of course, lead to a certain development of fibre manufacture when the use of this "bowstring hemp" is proved to be practicable. Ostrich feathers may also be exported, for a few ostrich farms might be made in this district. Plantations can only be formed in the valleys, and these differ from the Zambesi in the relatively smaller amount of good alluvial soil. Probably cocoanut palms will give the best result, as in German East Africa. Mr. Pigott, as the result of his experience at Magarini, told me that he did not believe that either cocoa, tea, or coffee would succeed; and cotton—as already stated—has so far been a failure on this coast. The clove tree is so valuable, and would seem so suited to this district, that no pains should be spared in testing its capacity of yield on the coast. We see, therefore, that the lower districts of English East Africa are not very promising, and that, in fact, only the cocoanut palm and cloves can be safely recommended.

Taking our colonies below 3,000 feet as a whole, we may perhaps conclude that the Zambesi possesses considerable prospects; but the knowledge that an experience of some 270 years has not enabled either English, Dutch, or Portuguese to make any considerable progress, should make us exceedingly cautious as to the future.

The cause of this want of success is undoubtedly the climate. It is not merely that a large per-centage of Europeans die or are invalided after a short residence, but the most pernicious effect is the reputation which keeps away so many farseeing and intelligent men who might otherwise have come. Perhaps the enervating depression which leads to regrettable moral degeneration and destroys both physical and mental energy in white and black alike is almost as important as a clog to all advance. Even with our own hold and experience in holding India we have not managed, after all, to make many profitable plantations below 3,000 feet in spite of the inexhaustible supply of intelligent labour. We have, however, both alluvial gold and coal in the Zambesi and Nyassaland which may alter the case considerably.

THE PLANTATION AREA, 3,000—5,000 FEET.

In British Central Africa at these levels we have already a thriving and flourishing community; and here my task is simply to point to proved results of a most satisfactory nature. The total trade of British Central Africa was as follows :—

1893.	1894.	1895.
£19,000.	£36,000.	£85,000.

Knowing, as I do, how the 8 or 10 people who made this colony, instead of being assisted in their efforts, were, in every conceivable manner, thwarted and hindered, this result appears to me as one of the most remarkable achievements of the Anglo-Saxon race.

German East Africa shows a very different result:—

1893.	1894.	1895.
£665,000.	£602,000.	£680,000.

The amount is enormously larger, but the increase in two years is under 2 per cent. (Of course, in both these cases, I have been obliged to take figures for the whole colony; in British Central Africa the amount of trade strictly due to the portion below 3,000 feet is insignificant,) The coffee of British Central Africa obtains the highest price in London; the average yield appears quite equal to that in Ceylon, and, in fact, its plantation is a proved success. At present the gardens are within a very small area—not more than 3,200 square miles—but there appears to be no climatic reason why it should not be grown anywhere in the colony, within the same altitudes. If we begin at the Manganja range, and pass along the eastern slopes of the Kirk mountains to the north of Nyassa, and down the eastern shore of the lake to Blantyre, we find that there is a belt nearly 970 miles long within those levels. This should be sufficient coffee ground for the whol of the civilised world.

One must not, however, forget that the coffe disease has broken out in German East Afric where there are also other injurious fungi an insects. One alternative may almost certain be found in tobacco, which Mr. Buchanan ha succeeded in growing profitably. It is als known that quinine, turmeric, ginger, hem and probably caoutchouc, grow in a very sati factory manner. It has yet to be proved th they are commercially profitable. Whea potatoes, and tomatoes also grow well; hors and cattle can be used for transport, which a most important point. In fact, at presen there is probably no better employment for young fellow with £500 or £1,000 capital tha coffee planting in the Shiré highlands. Th colonists can certainly be trusted to find alternative to coffee and tobacco in the futur I do not think this will be found in te The Indian tea districts seem usually to ha a far heavier rainfall than we find in the Shir Sibsagar, one of the lowest, has 93 inches Milanji, one of the best in this respect Central Africa, has only 77. But meteorologic data are not trustworthy in this respect, f we find Kandy, a typical coffee centre Ceylon, has 84 inches, while Zomba has on 36 inches of annual rainfall.

	Rainy Days.	Inch of Ra
Mombassa, below 3,000 feet	108	51
Kibwezi ,, ,, ...	44	29
Matschakos, above 5,000 feet........	84	42
Kikuyju, ,, ,, ...	118	59
Uganda (Natete), 3,000 to 5,000 feet..	114	47
Milanji, ,, ,, ..	199	77
Zomba, ,, ,, ..		36
Indian Tea Stations :—		
Silchar	157	120
Sibsagar	169	93
Assam and Cachar (average)		94
Indian Cinchona:—		
Mongpoo	133	126
Ceylon Coffee :—		
Kandy	186	84

This Table tempts one to point out what, a botanist, has frequently appeared to n probable. It is not the actual rainfall inches which is the most important clue to ommercial prospects of the climate, but more robably the humidity which can be most onveniently judged by the number of rainy days. It will be noticed that Milanji has actually more rainy days than the Indian tations. The amount of water carried off the ground by torrents and streams is so large hat an enormous per-centage must be of no use to plantations.

I should suggest indigo as the most promisng plant yet untried, and distinctly advise the olonists not to spend time and money on new ibre plants which can be, for the most part, uite as easily cultivated at places more adanced and far nearer a market.

In English East Africa, between 3,000 and ,000 ft., there is first the belt between Kibwezi ind Nzoi, about 40 miles wide; the rivers are ew, distant, and not permanent in this region, ind the rainfall at Kibwezi is only some 27 nches; moreover, this belt is farther from the oast than any part of Nyassaland from the Shiré river. Therefore it is, in many respects, nferior, and in no way, at present, superior to British Central Africa. On the inner side of he Masai highlands, round the vast Victoria Nyanza, there is a large district, best known is Uganda in this country, which also lies etween 3,000 and 5,000 feet. It may contain ome 3,000 square miles, and stretches from Ruwenzori and the Albert to the east of the great lake. Native products afford no clue inywhere to future* development, and Europan development has not begun.

The native products in this region are renarkably poor. The Uganda frankincense, 'mwafu," wax, and hippopotamus teeth are carcely worth mentioning, while ivory is ilready exhausted in Uganda, as Emin prophe-ied five years ago, and will, in my opinion, ecome quite insignificant in another five years. There is no proof of gold or other valuable minerals, and the iron can scarcely be exported. The country may be described roughly as a plateau of gneiss or granite, which is honeycombed, or, rather, cut out by winding, irregular, flat valleys, which probably occupy at least 20 per cent. of its total area. A section across a typical valley would show a flat, alluvial bottom, perhaps a mile wide, of which, perhaps, a quarter would be occupied by the rich, slatey-black ooze of the swamp, on which grows the papyrus reeds, 15 to 20 feet high. The rest of the valley bottom is covered either by dense forest, a long, rank grass, some 12 feet high, or the banana groves of the natives. This rank vegetation extends from a third to half-way up the hills, where it is replaced by the short grass, with a few scattered trees, which covers the exposed top of the ridges and hills. These summits appear to have a dry climate, after the character of the grass and trees; possibly, cattle may be reared on them, as the number of swamps implies an abundance of water at all seasons; but both the rich vegetation and the character of the soil seem to point to the valleys as being alone the seat of future advance. At present we find coffee in a half wild condition and not cared for in any manner, growing near the Victoria and up some of the valleys. The quality is excellent and is preferred to the "best Mocha" by the French missionaries. A small sample kindly given me by M. L. Decle was valued by Messrs. Patry and Pasteur at 75s. to 77s. a cwt. Probably the natives will cultivate it for sale to Europeans so as to diminish the cost of plantation, which might be serious in a country so far inland. Wheat and rice have been quite successfully grown by Europeans. The vast papyrus swamps appear indeed to be natural paddy-fields of an enormous extent. Cotton is indigenous and should, from the few specimens seen, be quite satisfactory. I do not believe that with a rainfall of only 55 inches either cocoa, tea, pepper, or vanilla can be grown with success, but the unfortunate point about the country is its distance from the coast. A railway 657 miles implies a cost of some £323 for expenses of running a train from the Nyanza to the coast (I do not think 10s. per train mile is at all an excessive rate in this country; it is 5s. in Natal). Assuming 40 tons as the load, this gives some £8 to £9 per ton, to which must be added freight to Europe, cost of plantation, &c. This seems to me to shut out of commercial consideration at any rate, maize, wheat, rice, beans, and peas (Messrs. Roffy and Sons valued specimens at 30s. per 480 lbs.), all banana products (7d. per 100 lbs. is the cost of this meal in Jamaica), and, in fact, everything except coffee, tobacco, and some doubtful products, of which the success is not certain (Captain Lugard suggests opium, olives, and the silkworm mulberry). It is, I believe, certain that this prohibitive cost could be diminished, perhaps by one half, through water transport, either by the Kagera and Tanganika or by the Nile, but that is a question of the future. Still this country may have great prospects; the alluvium of these valleys is Nile mud of the same appearance as that of lower Egypt, and sometimes 30 feet in thickness. Under firm European control, and with the Arab power destroyed, we may look to an enormous population, particularly if this is assisted by Christianity and freedom from the oppression of kings and small chiefs.

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* The following are the common widely spread native roducts in all tropical Africa :—

Maize—*Zea Mays*, "mahindi."
Millet—*Andropogon Sorghum*, "mtama."
Millet—*Pennisetum spicatum*, "mawele."
Hungry rice—*Eleusine coracana*, "wimbi."
Manioc—*Manihot utilissima*, "mahogo."
Sweet Potatoes—*Ipomœa batatas*, "viazi."
Edible arum—*Colocasia antiquorum*, "majuqu."
Beans and Peas—*Dolichas Lablab*, *Cajanus indicus*, *Vigna inensis*, *Phaseolus radiatus*, *vulgaris*, *lunatus*, *Canavalia nsiformis*. All these go by the name of "kundi" or 'maharagwe."
Calabash—*Lagenaria vulgaris*.
Pumpkins and gourds and yams, of which the species are iot clearly known.
Tobacco—*Nicotiana tabacum* and *rustica*.
Tomato—*Solanum lycopersicum*.
Also castor oil, Indian shot, chili, egg plant, &c.

In the African labour question, one is always apt to forget the essentially low grade of the negro. He is in that stage in which man lives in weak and scattered communities. When this is the case, constant marauding leads to the greatest waste of life, and also indirectly tends to kill out the peaceful and industrious races, who become enslaved by slave-making tribes. Slavery is in itself destructive of all incentive to work, and Arab domination is the worst of all conceivable forms of slavery; hence, the negro has never had a chance. In the West Indies, and also at Sierra Leone, business men have told me more than once that native labour costs about half, and is about half as efficient as European labour. If the effects of generations of slavery have been so far overcome in these countries as to make labour there equal in value to that of the white man, economically, there seems no reason to despair. The Kaffir population, in some districts in Natal, has trebled itself in 50 years, and, under European rule, this will happen everywhere. The doubtful point in the future will rather arise from too great a population.

The Waganda are quite the most promising of all African natives, and very keen to obtain articles of European manufacture. The difficulty is to utilise their labour, and make it pay for the imports which we can send them.

In the plantation area, therefore, the results are exceedingly promising, and all points to a sure basis of commerce. Labour will not be a difficulty; in Karongas, where formerly there was no possibility of obtaining a single nati workman, caravans of 1,000 every two or thr days are perpetually dispatched, and t population will increase to a degree which can scarcely realise at present.

THE COLONISATION AREA.

Above 5,000 feet is, according to Sir Jo Kirk, the only part of tropical Africa wh Europeans can permanently reside. Tl must also be below 7,000 feet, for above th level is a misty and cloudy zone which is all probability uninhabitable. The area British Central Africa, fit for colonisation, h not yet been tested; there are parts of Milan parts of the hills both east and west Nyanza, and a small portion of the Stevens road, which are above 5,000 feet. There a two stations in the last-named district, wh it has been proved already that cattle are qu healthy, and that wheat, oranges, figs, a even such a temperate plant as the stra berry, can be easily grown. These show th the essentials of European life exist. The f Europeans appear also to find the clima extremely healthy, but the evidence is as y incomplete. I have shown elsewhere th on both sides of Tanganyika there is similar elevated country ("Naturalist Mid Africa"), but as my object is show the resources of our own territory, shall pass on to the Masai highlands. Fr Nzoi to Kavirondo lies a country on whi every traveller becomes enthusiastic. It is region of grassy fertile plains and rolling hil varied by fine forests and beautiful sheets water. It is for the most part only travers by the war parties of the Masai; a ra at any rate, of an energetic character, a who are remarkably free from fever and non-contagious diseases. In the only pa in which cultivation is carried on, viz., Kiku and Ukambane, the native plantations a more extensive and more fertile than I ha seen anywhere in Africa.

Europeans in this country do not lose atrophy the distinguishing characteristics their higher race (*vide* Mr. Silva White). Th is shown physically by the extraordinary fea of endurance performed by Joseph Thomso Dr. Gregory, and others. As a botanist, th essentially European character of both gras plain and forests struck me as most remar able. Signs of drought only appeared in th Rift valley and the unexplored country to th west, and even in the former these signs we less marked than in most parts of Sou frica, *e.g.*, the Cape Colony, cattle (except r contagious epidemics), sheep, donkeys, ıd goats are thoroughly healthy.

Any one who has seen a Masai camp must ave been struck by the enormous number of ıimals, probably about four times the stock an ordinary South African farm, collected gether in a much smaller area than is usual r such farmers at the Cape. Moreover, the erds of antelope and other game which still ist in the Masai highlands, can only be mpared to those described by the early avellers in South Africa, or to the herds of son in the prairies. I see no reason why striches, angora goats, as well as cattle and e woolled sheep should not be reared in ıormous numbers.

Wheat can be easily produced, and European getables grow more vigorously than they do home. Native products, on the other hand, e almost unknown. A poison — *Acokan-erin*—prepared from the leaves of a plant, ill probably replace *Strophanthus*, if what said of its nature be proved, and there are ill a few elephants. Plantation prospects e not promising, for I find no evidence that ffee can be grown profitably above 5,000 et. But for colonisation the country seems tirely adapted; only the actual proof of its itability by experience is as yet wanting.

A very small capital would be sufficient to ove practically the prospects of cattle ranch-g and plantation in the Masai highlands. I ink that even £20,000 would be sufficient to ove the point. Government would probably ve some sort of optional claim on the land; ıd the transport requirements are so great at such an experiment would probably be ost remunerative; but the details are not ited to a paper of this kind. It should not forgotten that this is or soon will be the ly field for agricultural emigration, if we clude with it Matabeleland and Mashona-nd.

CONCLUSION.

I have tried to show, therefore, that our lonies in Africa have very various prospects. olonisation of an Australian type is only ssible above 5,000 feet. The results of plantion between 3,000 and 5,000 feet are so ıcouraging as to justify great hope for the ture. Below 3,000 feet the prejudice of some o years of an unsuccessful development presnts much prospect for the future; but there e now some four or five successful industries. rhaps I may now venture to give a few actical suggestions as to the future.

The first essential is the maintenance of our national policy of non-interference with planters and settlers. The opposite method operates as a most serious drawback to the development of the colonies of other nations. Dr. Kaerger, in the "Kolonial Jahrbuch," makes the following remarkable statement:—"In Deutsche Ost Afrika gehen handel und produktion zuruck in so weit sie von die Regierung beeinflusst werden Könnten und schreiten nur vor in so weit das nicht der fall ist." "In German East Africa trade and production decrease in the proportion in which they are influenced or might be influenced by Government, and improve in the proportion in which this is not the case."

The Government should certainly avail itself of the universal native law that protection should be paid for by labour. It is not necessary to adopt the corvée, but it would be possible to introduce a currency or allow rent to be paid in labour or produce. When, however, it comes to a question of what plant is or is not worth cultivation, the answer can only be given by practical men who risk their capital and prospects in trying to find it. Even German science at Bagamoy has been chiefly useful in showing how very useless an expensive botanical garden may be.

The next is to avoid monopolies or concessions, whatever the name under which they are disguised. Recent experience has proved again the truth of Adam Smith's remark:—"A company of merchants are incapable of considering themselves as sovereigns, even after they have become such. Their mercantile habits draw them to prefer the little transitory profits of the monopolist to the great and permanent revenue of the sovereign." Another is to trust the man on the spot with the fullest responsibility, and not to turn the administrator into a telegraph clerk. For subordinates in administration, it is above all things necessary to have properly trained men and the best men available. Practical engineering and rudimentary knowledge of tropical plantation are particularly requisite. It is only by offering the prospect of a career (and much to lose by inefficiency) that the right men can be attracted. In British Central Africa a railway is most urgently required. Both the Belgians on the west, and the Germans on the east of Tanganyika are attempting to get the trade of that magnificent lake, 400 miles in length. Therefore, if we wish to keep our two steamers on this lake fully employed, the railway (360 miles long) must be built at once. At present the Government is making a waggon track to the Masai highlands, in which they are doing entirely the best thing possible. I do not see myself the necessity of the Mombassa to Victoria railway until there is something to convey, and I believe the money would be better spent in rendering the country absolutely safe for Europeans, but in this opinion I do not find support from anyone. For our own country at present it seems to me that there are three requisites of paramount importance. First, an outlet for our congested capital and overflowing population. Secondly, new markets, and thirdly, that all our imports of food and the raw material of manufacture should be derived from countries directly under our own control. All these requisites are fulfilled by parts of our African possessions, and their importance may therefore justify the length of this paper.

DISCUSSION.

Mr. SCOTT KELTIE said the paper had been so full of information and so suggestive as to be almost bewildering. We wanted more men of Mr. Elliot's stamp in Africa. Those who were at school forty years ago would remember that at that time the whole of Central Africa, from the Sahara to the confines of the Cape, was one great blank; but since then that blank had been filled up with a network of routes. We had a general idea of the geography of the Continent, and what we wanted now was not so much the daring explorer as the scientific investigator. The information given by Mr. Scott Elliot was worth millions of money, and if it was turned to commercial purposes, ought to yield the author a handsome reward. He spoke of the possibility of colonising Africa above the level of 5,000 feet, and many people spoke of the outlet offered in Africa for the teeming populations of Europe and America. That had yet to be tried; theoretically it was possible, and they knew as a fact that Europeans had lived half a lifetime in the country, under certain conditions and at certain elevations, without being any the worse for it. But a longer experiment, one lasting three or four generations, was required before the question could be said to be settled. It would be a most important thing if such an experiment were made, in the Masai highlands, in order to see whether people from northern Europe could live there with their wives and rear children. In the Blantyre highlands this sort of thing had been going on for 20 or 25 years, during which time both missionaries and traders had been living there; and he was told that when you drew near the settlement one of the first things which attracted your attention were perambulators and nursemaids. He was assured, however, that so far it was found necessary to send the children home when they were seven or eight years old in order to be trained and educated. Whether it was really necessary, or whether the surrounding conditions of civilization rendered it advisable, morally rather than physically, must be a question. The diagram on the wall showing the increase of trade during the last three years in the country under the administration of Sir Henry Johnston was most striking. He had occasion lately to estimate the total value of the trade o Africa, and he found that the whole exports were only worth 100,000,000 sterling, from an area o 11,000,000 square miles. The value of the trade of India was 140,000,000 sterling from an area o 1,500,000 square miles. Of course, though that also was a tropical country the conditions were very different, but they had been vastly improved by irrigation and other means. In the same way, he had no doubt that in Africa, as it became necessary to bring it into the general economy of the world means would be found, not only for maintaining a European population in health, but for turning every class of land to account, from the sea level up to the highest inhabitable altitude. About 40 years ago the total trade of Africa was only 40,000,000 sterling, so that the progress made was very satisfactory. He hoped this paper would receive the attention it deserved.

The CHAIRMAN said they were much indebted to Mr. Scott Elliot for the singularly lucid, instructive thoughtful, and suggestive address he had delivered He had again drawn attention to that dark continen which had lately absorbed so much of their thoughts for recently it seemed as if public attention had been chiefly concentrated on Africa. A short time ago it was Ashanti, still more recently the Transvaal, and South Africa, where at any rate we had a splendid exhibition of that British pluck which was engaged in developing those regions; and that day their sympathies were concentrated on Abyssinia, where a terrible disaste had befallen our friends in Italy. From point to point of Africa our interests seemed to have been oscillating in recent times. All who took an interest in the future of the country must be eminently concerned in the partition of Africa, which was still going on, and which had been so ably dealt with by Mr. Scott Keltie. They must all feel desirous tha in that partition our own country should obtain and retain her fair share, and that, he took it, was th lion's share; for looking at it from a physiologica and ethnological point of view, he was satisfied tha in the long run the Anglo-Saxon race must attain dominion throughout the greater region of Africa, and it was certainly our duty to retain a firm grip of what we had secured, and by all legitimate means to extend our influence. We could not lose sight of the fact that we were in constant and growing need of outlets for the enterprise of our youth and for the consumption of our products and that Africa offered an enormous field in both directions. We might congratulate ourselves that we had at present a Colonial Secretary who was fully alive to the imperial interests of the country, and who would do all that could properly be done to develope that region. If Mr. Scott Elliot had brought back nothing with him from Africa but the information about the *Euphorbias*, which was such a protection against barnacles, his journey would not have been in vain. He trusted that when the facts he had collected were fully grasped it would lead to the formation of syndicates for the development of the region of Africa he had visited. One thing not to be forgotten was that the choicest parts of Africa, those between the 3,000 and 5,000 feet level, which were most easily colonised, were almost without exception in British hands. As a medical man he had no doubt whatever that in those regions English men and women might settle with perfect safety to their health, and rear their children there also. As regarded sending children home there was probably a good deal of fashion about it; there was an idea that they could not be properly reared there, and there was also the educational question. But *pace* Weissman's theories, he felt sure that the human race had a great power of adaptation, and that in a few generations, at any rate, children of European race might be reared there with perfect safety. They must not lose sight of the fact, as shown by Mr. Cantlie's investigations, that in London children could scarcely be reared safely, for it appeared that in the inner area of London, to which ozone rarely came, purely London families did not survive the third generation. Therefore those who lived in London ought to send their children away into the country, just as the missionaries in Africa sent them home to England. He concluded by proposing a hearty vote of thanks to Mr. Scott Elliot, which was carried unanimously.

Mr. SCOTT ELLIOT, in reply, said at present it seemed to be considered necessary to send children home from British Central Africa, but he remembered on one occasion making a long and difficult march of about twenty miles and he was accompanied by a little boy (son of the Rev. Mr. Watt), who walked beside him almost the whole day, being only carried about half the distance. He thought if that were possible now it said a good deal for the future of children in those regions.

INDIAN SECTION.

Thursday, March 19, 1896; Sir CHARLES H. T. CROSTHWAITE, K.C.S.I., in the chair.

The CHAIRMAN, in opening the meeting, stated that as Mr. Glass, was in India, Mr. Digby, the Secretary of the Indian Section of the Society of Arts, would read the paper. It gave the history of a catastrophe of a wonderful description, and of the very successful way in which it was dealt with by the Public Works Department in India in the prevention of loss of both life and property.

The paper read was—

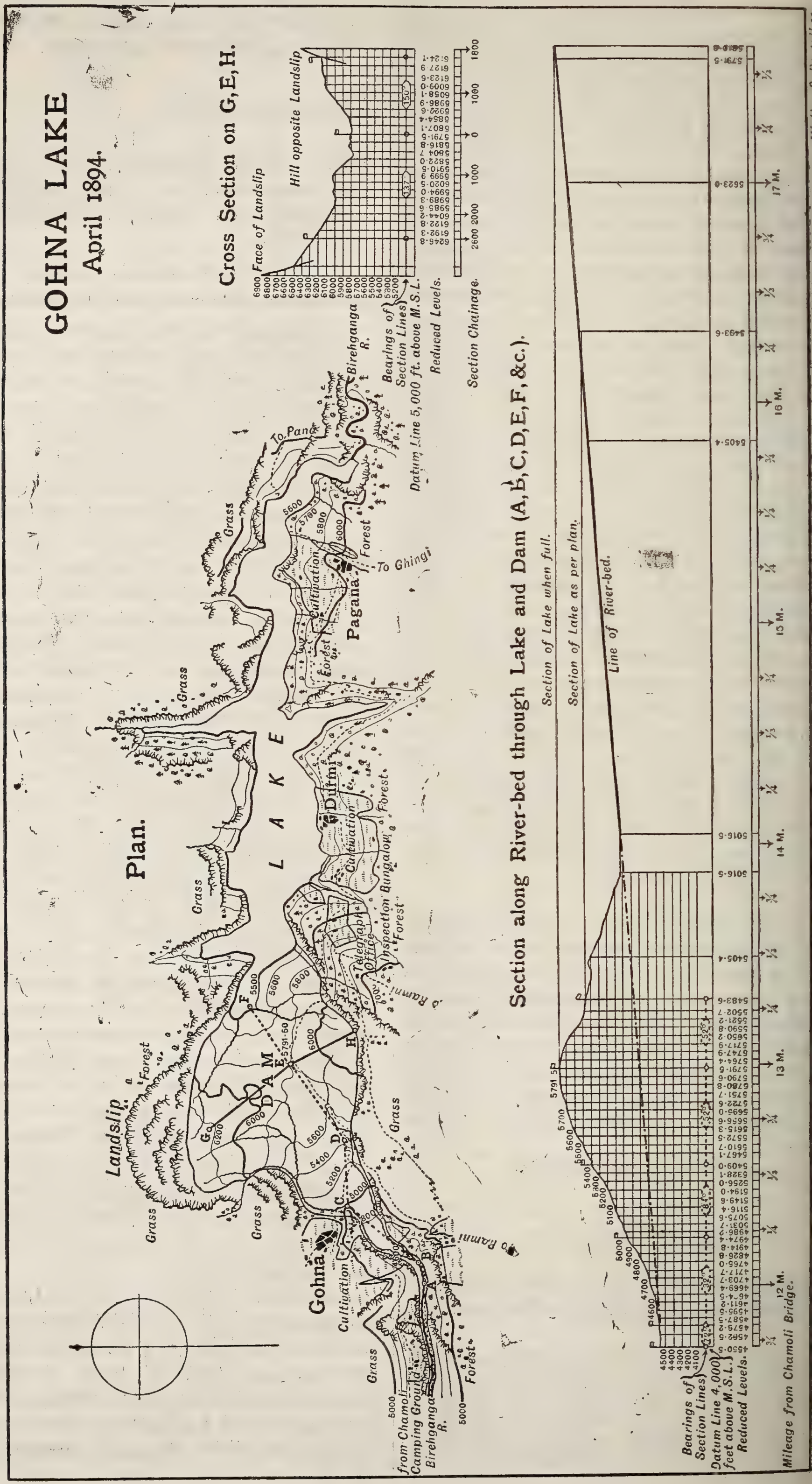
THE GREAT LANDSLIP AT GOHNA, IN GARHWAL, AND THE MEASURES ADOPTED TO PREVENT SERIOUS LOSS OF LIFE.

By J. H. GLASS, C.I.E.,

Chief Engineer and Secretary, Dept. Public Works, Bengal.

It is proposed in this paper to give a brief account of the great landslip which occurred at Gohna, in Garhwal, British India, towards the end of 1893, by which the course of the river Bireh Ganga, was completely blocked, and a large lake formed; and also a description of the measures instituted and carried out by the Government of the North-West Provinces and Oudh, of which Sir Charles Crosthwaite, K.C.S.I., was Lieutenant-Governor at the time, to ensure the safety of the inhabitants of the valley through which the flood would pass when the lake overflowed. The information on which the paper is based is derived from reports submitted to Government by Colonel R. R. Pulford, R.E, Superintending Engineer, Public Works Department, who was placed in charge of the operations taken to protect life and property from the effects of the anticipated flood, by Mr. R. A. Cordner, C.E., Superintending Engineer, Public Works Department, who carried out the measures for the protection of the Ganges Canal headworks at Hardwar; and by Mr. T. H. Holland, of the Geological Survey of India, who was specially deputed by the Government of India, at the request of Sir Charles Crosthwaite, to examine and describe the geological features of the locality, and to investigate the causes which led to the landslip. The writer was at the time Chief Engineer and Secretary in the Public Works Department to the Government of the North-West Provinces and Oudh, and the responsibility of advising Government as to what steps should be taken in dealing with the case devolved upon him.

The district of Garhwal is in the Lieutenant-Governorship of the North-Western Provinces, and lies 29° 26′ and 31° 5′ N. lat., and between 78° 17′ 15″ and 80° 8′ E. long. It forms the north-western district of the Kumaon division. It is bounded on the north by Chinese Tibet, on the east by the Kumaon district, and on


GOHNA LAKE
April 1894.
Plan.
Cross Section on G,E,H.
Face of Landslip
Hill opposite Landslip
Bearings of Section Lines
Datum Line 5,000 ft. above M.S.L.
Reduced Levels.
Section Chainage.
Section along River-bed through Lake and Dam (A,B,C,D,E,F, &c.).
Section of Lake when full.
Section of Lake as per plan.
Line of River-bed.
Bearings of Section Lines
Datum Line 4,000 feet above M.S.L.
Reduced Levels.
Mileage from Chamoli Bridge.
12 M.
13 M.
14 M.
15 M.
16 M.
17 M.
LAKE
DAM
Landslip
Gohna
Pagana
Durmi
Cultivation
Forest
Grass
Telegraph Office
Inspection Bungalow
To Ghingi
To Pana
to Ramni
Birehganga R.
from Chamoli
Camping Ground
Walker & Boutall sc.

the west by Independent Garhwal, or Tehri, and the Dehra Dun district. The estimated area is 5,500 square miles, and the population is about 350,000 persons. The administrative head-quarters are at Pauri, but Srinagar is the chief town of the district. The district of Garhwal consists, for the most part, of rugged mountain ranges, the central peaks or outlines of the main Himalayan chain tossed about in the most intricate confusion, and severed by narrow valleys which may rather be described as gorges or ravines. The broadest among them, that of Srinagar, measures barely half-a-mile in width, and has an elevation of 1,820 feet above sea-level. To the north the mountains belong to the central upheaval line of the Himalayas, the principal peak within the boundaries of Garhwal being Trisul, 23,382 feet; Nanda Devi, 25,661 feet; Dunagiri, 23,181 feet; Kamet, 25,413 feet; Badrinath, 22,901 feet; and Kedernath, 22,853 feet.

Gohna, where the landslip occurred, is a small village in Garhwal with a population of less than 200 persons. It is situated in lat. 30° 22′ 18″ N., and long. 79° 31′ 40″ E., and ies on the right bank of the Bireh Ganga, a ributary of the Alaknanda river, which—after ts junction with the Bhagirathi, at Deopryag, 2 miles above Hardwar—is thenceforth known s the Ganges.

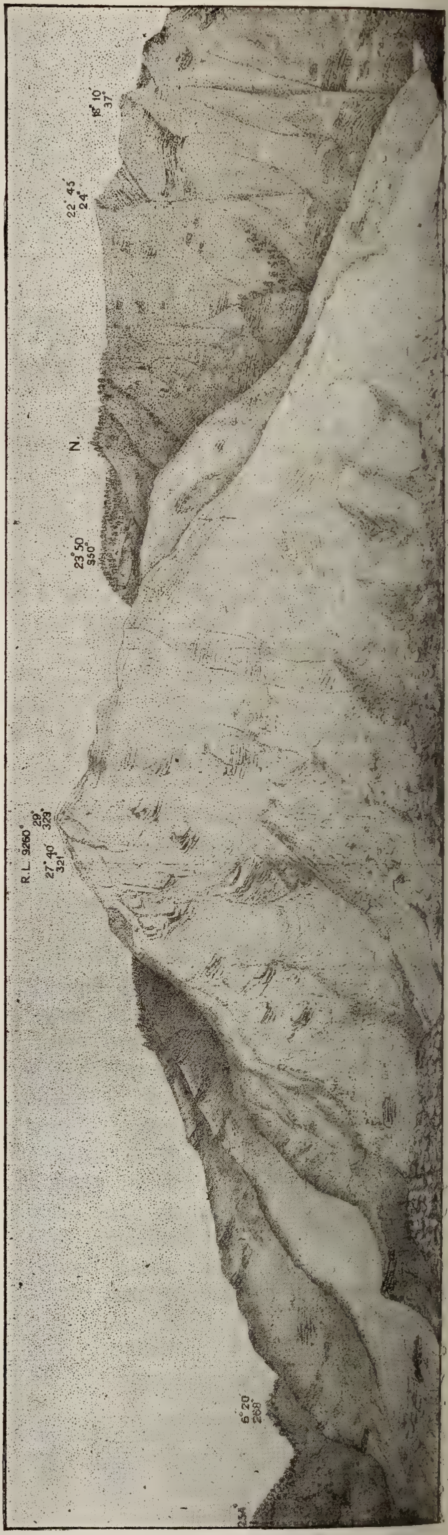
Hardwar, a very ancient town, and famous s a place of pilgrimage amongst Hindus, is ituated at a gap in the Siwaliks, through which the Ganges river, after passing out of he Himalayas, debouches upon the plains of Northern India. The Alaknanda river forms ne of the holiest amongst Indian objects of everence, and each of the points where it neets a considerable confluent is regarded as sacred station in the pilgrimage which devout Hindus perform to Himachal. The above description is taken chiefly from Hunter's "Imperial Gazetteer of India." The distance rom Gohna to Hardwar, measured along the iver route, is about 150 miles. The country s sparsely inhabited and cultivation is not eneral. At certain points along the river ourse, there are, however, places of some ize; and there is a constant stream of pilrims passing from the sacred town of Hard'ar to Badrinath and other sacred shrines in ne Himalayas.

Floods of great severity are not unknown in ie history of Garhwal. It is recorded that, rior to the Goorkha conquest, in 1803, one reat flood occurred, which swept away half ie town of Srinagar; and the disastrous effects of a high flood which passed along the Alaknanda valley, in 1868, owing to the bursting of a lake which existed at no great distance from Gohna, and which was also probably formed by a landslip, are still fresh in the memory of the people, as it was attended by a considerable loss of life, and the destruction of much property. At that time the late Sir Henry Ramsay was Commissioner of Kumaon, and, in reporting the occurrence of the flood to Government, he remarked that several bridges along the valley had been carried away, and that at Chamoli some houses, near the bridge there, which were crowded with pilgrims on their way to or from Badrinath, were submerged. The accumulated waters, he adds, came down so suddenly at night, that there was no warning, and only a few of the pilgrims, probably awoke by the noise of the rushing waters, who at once ran up the bank, escaped; all the others, with the houses, were swept away. Much animal life was lost, and a considerable amount of property destroyed.

On the 19th of November, 1893, the first intimation of the Gohna landslip reached Government. It was contained in a report from the Commissioner of the Kumaon division, in which Gohna is situated, and gave merely a brief outline of what had occurred. The district authorities had heard from a native source that early in the previous September an enormous mass of material from the Maithana hill had subsided into the Bireh Ganga river, completely blocking it, and that a large lake was under course of formation. For some time afterwards material continued to fall, huge blocks thundering down the hill, and crashing into the mass below, but there was no further fall of any size till about the end of October, when a great slice of the hill moved forward into the valley, making an effective barrier of enormous proportions, and completely obstructing the flow of the river. The falling mass was accompanied by a deafening noise, and the neighbourhood for miles around was filled by clouds of dust, which whitened the ground and tree branches like snow. Gohna is situated away from any road route, and is most difficult of access, so that it was not possible to obtain readily any accurate account of what had really happened. The reports which had reached the Commissioner of the occurrence were from villagers resident in the vicinity, who did not realise the grave nature of the danger which threatened. All that was known was, that a great landslip had taken place, blocking the river, and that a lake was being formed, which, in the process of time would assuredly top the obstruction and hurl its accumulated waters along the valley of the Alaknanda river to the Ganges. No information was afforded regarding the size of the landslip, or what dimensions the lake would be when it had filled to overflowing. It was, therefore, necessary to depute an experienced officer to make an examination of the place, and to furnish Government with precise information regarding the landslip. As has already been mentioned, the first intimation of the accident reached Government on the 19th of November, and on the same date orders were issued by the Lieutenant-Governor, to Colonel R. R. Pulford, R.E., Public Works Department, to proceed to Gohna with all possible despatch, and to submit a detailed description of the landslip and the lake which was being formed, and to report on the measures to be adopted to prevent the loss of life and the destruction of property which might follow on the sudden release of the accumulated waters.

It was impossible for Colonel Pulford to start immediately on receipt of orders, as he had to make arrangements for the transport of necessaries, in the way of food and tents, neither supplies nor shelter being available at Gohna. He lost no time, however, in completing his arrangements; and on the 28th of November he started, and arrived at Gohna on the 12th December. The climate of Garhwal at that time of the year is severe, heavy falls of rain and snow being common, and the absence of shelter huts and the badness of the road make travelling at that season particularly arduous.

The result of Colonel Pulford's inspection was made known to Government in a demi-official letter, dated the 21st December. He reported that the mass of earth and rock composing the landslip was about 900 feet in height, 2,000 feet across at top, 11,000 feet at the base along the valley, and 3,000 feet at top and 600 feet at bottom across the valley. These figures give an idea of the magnitude of the slip. It was largely composed of enormous masses of rock, some of which, lying on the surface, were calculated to be many tons in weight, with an admixture of detritus and a thick layer of white impalpable powder over all. The slip had taken place from a precipitous hill bordering the river on the right bank. The hill, which is called Maithana, has an elevation at the summit of about 11,000 feet above sea-level, and the part from which the



ll occurred is about 4,000 feet above the bed f the stream. The force of the fall from so reat a height as 4,000 feet carried the rocks nd *débris* right across the valley of the river, nd for some distance up the steeply scarped ill on the left bank ; then, its energy expended, e mass slipped back into the valley, forming dam, with a big slope up against the hill on e left bank. The further great slip in October lled up the dam on the right bank against the ill on that side, in such a manner that the top f the dam had a large depression some 150 et below two sloping mounds of rock and *ébris*.

The bed of the Bireh Ganga river slopes at bout 250 feet per mile at Gohna, and is the ottom of a narrow gorge, with steep, and ometimes precipitous sides. The gentler lopes of the hills are grass-covered at the ase, and, higher up, are clothed with everreen, oak, fir, and rhododendrons. Immeiately below the slip, the course of the river urns nearly at right angles, and passes hrough a narrow gorge, with precipitous ides of rock. In the more open parts of the alley the slopes are terraced, with great abour, for cultivation ; but the configuration f the ground and the nature of the soil are uch as to prohibit any large amount of cultiation. The river basin at Gohna, draining nto the lake formed by the landslip, has an rea of about 90 miles, and is bounded on the orth and east by a snow-clad ridge of the Iimalayas, rising to an altitude of 21,200 feet bove sea-level. A large portion, therefore, of he water of the river is derived from the meltng of the snows, and this supply is, of course, t its greatest during the hot season.

One of the most important questions to ecide was, how long it would take the lake to ll. It was not possible to accurately calcuate this, owing to there being several unertain factors. They were—(1) the extent and uration of the winter rains ; (2) the amount f snowfall, and the quantity of water which ight be expected from the melting of the now on the hills within the basin area ; (3) he loss from the lake on account of percolaion and absorption. There were absolutely o data available at the time from which to rrive at even an approximation of those several uantities, and it was, therefore, only possible o make at first a very rough calculation of he time that it would take the lake to fill. rom the information then before him, Colonel ulford fixed the date on which the water ould rise to the top of the dam as the middle of May. Later on, however, when data in regard to the area enclosed by the landslip, and in respect to the rainfall and snowfall during the year over the catchment area of the river had been collected by the Public Works officer who was sent to Gohna for that purpose, Colonel Pulford reported that the lake would probably overflow about the middle of August ; and the 15th of August was accordingly adopted as the date by which all arrangements for dealing with the flood should be in working order. It speaks well for the care and precision of the forecast that the actual date on which the lake topped the dam was the 25th August, or ten days later than that arrived at by calculation. On the return of Colonel Pulford from Gohna, a committee composed of officers of the Public Works Department assembled at Lucknow to consider what measures should be adopted for the protection of life and property along the route which the flood would take on its way to the Ganges. It was suggested by Colonel Pulford that a telegraph line should be constructed from Hardwar, to Gohna, following the river route, and having stations at all important places along the valley. The committee strongly supported this suggestion, and urged immediate effect being given to it as affording the only means by which the authorities would be kept informed of what was going on, and enable them to give timely warning to the residents in the valley, and to the numerous pilgrims of the approach of the flood. Without the telegraph line, the Government officials as well as the people who were concerned, would be in suspense for weeks, and the first intimation the latter would have of the bursting of the dam would be the flood at their doors, attended by the destruction of their property and probable loss of life. Without the telegraph line it would have been necessary, as a precautionary measure, to have closed the road along the valley used by the pilgrims, and had so extreme a measure been taken, great hardships would undoubtedly have been inflicted on the people, and it would have caused considerable indignation amongst the Hindu community. The road in question only admits of foot traffic, and has been in use for a great many years, as affording the only route to the holy shrines in the valley of the Alaknanda, and in the Himalayas. The North-West Provinces Government has from time to time expended considerable sums of money on improving it. Mountain torrents have been spanned by suspension bridges, precipitous paths eased off and rendered safe for foot traffic, and bazaars established to provide pilgrims with supplies. It is impossible to over-estimate the benefit conferred on the pilgrims by not closing the road. The sanction of the Lieutenant-Governor was given at once to the construction of the telegraph line, and arrangements were immediately made with the Director-General of Telegraphs for the speedy creation of the line. It was decided that there should be ten telegraph signalling stations, inclusive of the two terminal ones at Hardwar and Gohna. The places selected for signal stations were all sacred spots at which pilgrims halt in their journey to Badrinath and Khedernath. The pryags, or junctions of tributary rivers with the main Ganges stream are, as has been previously mentioned, looked upon as being especially holy, and the camping grounds set apart for the pilgrims are situated close to the edge of the river. It was essential, therefore, to take every possible precaution at such places, and the opening of signalling stations was a most necessary measure. It was settled by a subsequent committee that, as soon as the Public Works Department could form a reliable opinion on the point, they would erect masonry pillars at suitable intervals along the valley line, to show the probable safe limits which would be out of the reach of the flood. A civil functionary was to be placed in charge of the protective arrangements at each station, who would be responsible that the patrolling of the line between stations was properly carried out, and on receipt of the warning telegrams from Gohna, that the lake water had reached the summit of the dam, that all persons within his beat were securely placed above the safety level. All the civil officers along the line were under the orders of the Deputy-Commissioner of Garhwal, who was in close and constant communication with Colonel Pulford. Lieut. Crookshank, Royal Engineers, was placed under the orders of Colonel Pulford for special duty in connection with the operations, and he was directed to proceed to Gohna from Hardwar along the valley of the Alaknanda. He was instructed to inspect the various camping grounds resorted to by pilgrims, to observe their position in respect to the river, and to select places of safety as close to them as possible to which the pilgrims could flee when intimation was given of the bursting of the lake. He was also to report on the state of the bridges along the route, which it had been decided to dismantle, and to select suitable sites for rope bridges (locally known as *julas*) for temporary use whilst the permanent bridges were not available. On arrival at Gohna he was directed to prepare detailed surveys and sections of the slip, to make a contoured map of the lake, so as to admit of the contents being calculated, and to prepare a sketch survey of the country in the immediate vicinity of the lake. He was accompanied by a staff of native surveyors to help him in his work, and by an excellent native photographer by whom a number of photographs were taken not only of the lake and the slip, but also of points of interest in the valley between Hardwar and Gohna. Lieut. Crookshank built himself a small hut close to the site of the lake, and he remained there watching operations, and carrying out the surveys referred to, until some time after the bursting of the lake on the 25th of August.

The District Surveyor, Hari Kishur Pant, was also employed on the protection operations, and was placed in charge of the dismantlement of the bridges it was decided to pull down, and the erection of *julas* in lieu of them. This part of his work was carried out with commendable speed, and the permanent bridges were dismantled and temporary structures erected in their place sometime before the final catastrophe. He was also entrusted with the important task of constructing masonry signal pillars at selected points in the valley from Hardwar to Gohna. The pillars were 4 feet by 4 feet and 6 feet high, placed at an elevation of 200 feet above ordinary flood-mark in the valley from Gohna to Srinagar, and 100 ft. above the same datum in the valley below Srinagar. Instructions were drawn up by Colonel Pulford for recording the flow of water over the dam at Gohna, and down the valley to Hardwar, and also in respect to the relations of Public Works officers in charge of observing stations with the civil officers.

The chief point to be provided for was that due intimation of the coming flood should be conveyed to each of the stations along the line, in time to allow of proper arrangements being made for the removal of the inhabitants of villages which would be affected by it, and of pilgrims, to places of safety above the flood limits. The instructions on this most important point were as follows:—The rapidity with which the lake water may be expected to cut through the dam at the last will depend greatly on the time of year at which this happens. If it takes place before the coming of the rains, the officer on the spot will be able to judge with a near approach to accuracy of the exact time when the water will appear over the crest. Should it, however, occur during the rains, the action of the rain on the surface of the dam will weaken it considerably, and the final catastrophe may probably be considerably hastened beyond what it would be in ordinary dry weather. For these reasons the officer in charge at Gohna (Lieutenant Crookshank, R.E.) should send a warning telegram down the line intimating that the water in the lake is approaching the top of the dam, when it is 50 feet from the top during the rains, and when 20 feet from the top if the rains have not broken. This warning telegram should be sent to each station along the line, to the Secretary to Government Public Works Department, to the railway authorities, and other officials concerned. Other warning telegrams should be sent when the lake water is within 48 hours of reaching the top of the dam. For the purpose of observing the action of the flood when passing over the dam, masonry bench marks about 50 feet apart, measured horizontally and numbered consecutively, were built on the upper portion of the down-stream face of the dam. The numbering was in large figures, so as to be plainly observable from the side of the valley. The object of these pillars was to allow of a reliable record being made of the way in which the water of the lake, when discharging, cut away the material of the dam. The time at which the water first appeared over the crest was to be noted, and then the time at which each of the other pillars disappeared by the action of the water. The rate at which the water subsided in the lake was to be recorded every hour by means of bench marks placed on the hill slope at the edge of the water. The contents of the lake had been calculated at vertical intervals of one foot from the excellent contoured map prepared by Lieut. Crookshank, so that the quantity of water flowing out was readily obtainable, once the amount of subsidence in the lake level was ascertained.

Immediately below the rear slope of the landslip the river, as has already been mentioned, turns almost at right angles to its course and passes through a narrow gorge with precipitous sides of rock. The sides of the gorge were marked off with figures in such a manner as to make it an easy matter to record the rise of the flood when passing. At other observing stations along the valley, well-defined marks, visible by day or night, were put up by which to record the rise of the flood Each observer was provided with a clock, regulated by the clock of the telegraph office, and a note-book, and full instructions were given as to the method of recording. After the first arrival of the water its rise was to be recorded every quarter of an hour by reference to the bench marks previously mentioned. The velocity of the flood was also to be noted by taking the time which a block of wood or other floating object occupied in passing between two fixed points, the distance between which was known.

Meantime, though work in every department was proceeding vigorously along the line various points in connection with the operations had been made the subject of discussion in the public papers. The chief question taken up was the advisability of cutting a channel through the dam, with the object of allowing the water to run off before the level of the lake reached the full height of the dam. This matter had received very full consideration from Colonel Pulford when he first inspected the dam in December, and the conclusion he came to was, that it was not feasible to cut any channel that would be of any practical benefit. In this view the Government of the North-Western Provinces and Oudh thoroughly concurred after a careful study of the circumstances attending the case. The mass of water which must, in any case, be headed up, and which must eventually cut through the upper soft layers of the dam, would cause a serious flood of practically the same intensity as would occur if the dam were left untouched. This opinion was based on the estimates which had been made of the probable depth to which the action of the lake water would cut through the dam when passing over it. It was approximately calculated that about 250 feet vertically of the dam would be carried away by the first rush, but as the cutting and eroding action of the enormous body of water represented by that depth would be terrific, it was not possible to fix a limit at which the cutting action would cease. As a matter of fact, the flood torrent when it occurred, cut away some 390 feet vertically before the body of the dam was able to resist the action. Under such conditions it appeared to Government that it would have been wasteful extravagance to have spent large sums of money on an undertaking which would have been of no practical use. The difficulties attending the making of a cut of even 20 feet deep would, on account of the numerous large detached masses of rock, have been enormous, and for a cut of 50 feet or 100 feet almost insurmountable. A channel 50 feet in depth would still have left a depth of over 700 feet in the lake, and the amount by which it would reduce the flood would be practically inappreciable as compared with the whole volume, while the cost would not have been less than a lakh of rupees. One of the effects of cutting a channel would be to accelerate in a measure the escape of the pent-up waters. The advantage of doing so was very questionable, as it would have caused a flood in the Ganges at Hardwar before the temporary headworks which are put up yearly at the end of the rainy season for the purpose of supplying water to the Ganges Canal had been removed, and their safety and that of the canal would have been endangered.

A cut 100 feet in depth, still leaving nearly 700 feet of water in the lake, would have necessitated the employment of an army of workmen numbering not less than 7,000 persons, and nearly all would have had to be imported, as there is practically no labour available. It would have been necessary to hut the labourers and to arrange for food supplies, all of which would have had to be carried for many miles on mules and ponies, as there is no road to the landslip on which carts can travel. The cost might have been kept within three lakhs or so, but bearing in mind the expenditure entailed in collecting and hutting so large a number of men, and in providing a commissariat, it might easily have amounted to a much larger sum. To construct a large weir with a system of falls and shoots, as was suggested by one of the critics, would have cost an enormous sum of money, and could not besides have possibly been completed within the time available, that is, before the advent of the rainy season. After a due consideration of all the circumstances of the case, Government decided that to undertake works for passing out the water of the lake under control would be a waste of money and would not result in any advantage. In spite, however, of all arguments to the contrary there was throughout the progress of the operations a large and influential section of public and private individuals which held that an effort should have been made in that direction. One gentleman offered, for a certain pecuniary consideration, to make arrangements for the escape of the water so that it would pass away without doing any harm whatever, and several others came forward with proposals of a similar kind, but all required that they should first receive large advances of money to enable them to prepare their schemes and put them into working order.

The following is an abstract translation of a petition from Mirza Mahomed Husain Vakil resident of Mohalla Bunglow Azad Khan, City Rampur, dated 22nd August, 1894, giving his views as to how the matter should be deal with :—

> " Referring to the Gohna Lake matter now engaging the attention of Government on account of the vast loss of life and property apprehended from the possible collapse of the wall of the lake, and with a view to successfully warding off such a calamity, the petitioner suggests the following measure for adoption by Government, and explains the principle of hi contrivance by means of a rubber tube, which he say he encloses with his petition, and illustrates hi principle by means of a diagram. As in the diagran the tube must be bent making one leg longer than the other. The ends should then be uplifted, the tube filled with water and fingers firmly applied to both the ends. The tube should then be inverted the shorter leg dipping into a basin full of water The longer leg must always occupy a somewha lower level than the shorter leg. The fingers should now be removed from both the ends, and it will then appear that the water will continue to run down the longer leg until it has fallen below the level of the shorter leg in the basin. The basin in this experimen represents the lake in question. Suggests tha suitable rubber and iron tubes may be constructed and applied on this principle, and the lake emptied of water to the desired level and the water thus drawn be distributed over any desired area."

No fee was claimed for this advice.

Other objections taken were that the height of the safety pillars fixed along the valley were arbitrary and absurd, and that the rate of twenty miles an hour calculated as the velocity at which the flood would pass down the valley was exaggerated and improbable. Also that the telegraph line was not required and was a wasteful extravagance, and that the dismantling of the bridges was quite unnecessary Some persons, wise in their own esteem gravely urged that there would be no cutting away of the dam and no flood, but that the water would, when it rose to the top of the dam, pass quietly over the crest and down the face of the talus into the regular river channel, without causing more damage or erosion than would be produced by the passage of an ordinary flood over the boulder bed of the river.

In June, 1894, a final visit of inspection was made by Colonel Pulford along a part of the valley line, and he found that the arrangements for dealing with the flood were wel advanced. The temporary telegraph line was completed and offices had been opened at the following places:—

1. Gohna, near the dam.
2. Chamoli, 14 miles from Gohna.
3. Nandpryag, 21 miles from Gohna.
4. Karnpryag, 31 ,, ,, ,,
5. Rudrapryag, 52 ,, ,, ,,
6. Srinagar, 72 ,, ,, ,,
7. Deopryag, 88 ,, ,, ,,
8. Byasghat, 97 ,, ,, ,,
9. Rikhikesh, 133 ,, ,, ,,

The last-named place was connected with the telegraph office at Hardwar, 149 miles from Gohna. Huts for the accommodation of the telegraph staff had been put up; and substantial *julas* had been erected at suitable sites in place of the dismantled permanent bridges. At the special request of the local authorities two suspension bridges, which, in their opinion, were well beyond the influence of any flood which was likely to happen, were not dismantled, although the Public Works Department recommended that they should be. As will be shown, they were both completely wrecked by the flood. The large masonry pillars marking the limit below which it would be unsafe for the people to remain were ready. They were erected at all villages and camping grounds and elsewhere at intervals of half-a-mile along the entire length of the valley, and their sites were so chosen as to allow of every pillar being visible from a long distance on each side of it. These pillars were the subject of much unfavourable and sarcastic comment, not only by the ignorant villagers for whose benefit they were provided, but by others who should have known better. It may, however, be remarked here, that of all the operations taken to ensure protection of life and property, the erection of masonry pillars at carefully-selected sites was by far the most important and far-reaching, with the exception of the telegraph line. With these limits of safety suitably fixed, the task of protecting the people became simply a question of getting timely warning of the approach of the flood.

Now that the precautionary measures adopted by Government for the protection of life and property have been described, it may be convenient to give some account of the cause to which the landslip was attributed. I cannot do better than quote from the very interesting report on the subject submitted by Mr. T. H. Holland, of the Geological Survey of India, who, as has already been mentioned, was specially sent to Gohna by the Government of India, at the request of Sir Charles Crosthwaite, to inspect the landslip and to report on it. Mr. Holland visited Gohna in February and March, 1894, some five months after the landslip occurred, and when the lake formed by it had risen to 290 feet of the top.

Mr. Holland's report is published in Vol. xxvii. of "The Records of the Geological Survey of India." He writes:—

> "It is easy to trace several causes which have been for some time conspiring to the one end of bringing about the catastrophe that has been attended by such serious consequences at Gohna. Among these the principal, or more correctly the one which gave facilities for the action of all the others, is the dip of the strata towards the gorge. Plate I. shows the complicated manner in which the beds are crumpled in this area. At the same time it will be noticed that over Gohna village the dip of the dolomites in the south-east direction increases until in Maithána itself the beds are inclosed in the face of the cliff at an angle of about 45° to 50°, and consequently large platey surfaces are exposed by the fall. As the dip of the rocks is here greater than the angle of repose of dolomite, or shale-slabs, sliding would naturally take place when necessary facilities are presented. As long as the slope of the surface does not exceed in angle the dip of the strata, there is no danger of a slip; but when, as in this case, the foot of the slope is undermined by the action of a river and springs, the average slope of the surface is increased and there is a tendency for the beds lying between the line of slope and the line of dip to slide off. If the beds are well cemented and only subject to the influence of their own weight, the surface slope may greatly exceed the dip (and the angle of repose) before sliding commences. The influence of the dip of the strata in fashioning the surface slope is also well illustrated in the Cheddar Valley in England. The river has cut a gorge in the direction of the strike of the carboniferous limestone which dips on both sides of the river at an angle of 15°-24° S. The south side of the gorge is an almost perpendicular cliff, 400 feet high, whilst on the north side the slope is only slightly greater than the dip of the beds which are constantly, though gradually, slipping down as the river is deepening its valley. Thus, whilst an almost perpendicular cliff is safe on the south side, in which direction the rocks dip, there is a perpetual slipping on the north side, and no slope greater than the angle of repose of the loose blocks would be safe. In the landslip at Gohna not only was the support removed by undermining at the foot of the slope and loosening of the beds, but the beds were impelled outwards by a series of changes following as a natural consequence of the processes which destroyed the originally compact nature of the strata. These causes combined, taking advantage of the stratigraphical

facilities, precipitated the mass of material which now dams back the Bireh Ganga. Taking these causes in order we have—

"1. Those producing a loosening of the strata—(a) Dolomitization; (b) solution by atmospheric waters; (c) reduction of co-efficient of friction by water.

"2. Subsequent changes impelling strata in the direction of least resistance—(a) Expansion of products on oxidation and hydration; (b) changes of temperature; (c) hydrostatic pressure.

"LOOSENING OF THE STRATA.—(a) *Dolomitization.* — The change of ordinary limestone into dolomite (which has only been partially effected at Gohna) on account of the lower molecular volume of magnesium carbonate, is accompanied by an increase of specific gravity from about 2·73 to 2·83, and consequently corresponding decrease in volume. The vesicular and jointed characters of many dolomites are probably thus caused, although the visible effects may often be prevented by pressure; but even under conditions of pressure, dislocations once produced offer facilities for subsequent agencies, as, for example, removal by solution, or introduction of other minerals like iron pyrites with which the Gohna rocks are highly charged.

"(b) *Solution by Atmospheric Waters.*—Besides the mere solution along joint and bedding planes—a process inevitable wherever atmospheric waters circulate amongst such rocks—minerals like iron pyrites become decomposed, and the products of oxidation and hydration act as solvents for the production from dolomite of sulphates of lime and magnesia, which are carried away at once, or ultimately, in solution. Except for these changes combined, I should find it difficult to explain the amygdaloidal cavities in the dolomite referred to; and apart from such an unusual manifestation of their effects as these cavities, there is no doubt of the rocks being loosely jointed and channelled in numerous directions. The large cavities and 'swallow holes' described by Mr. Middlemiss in the dolomites of Naini Tal are examples of the changes brought about by the agencies here referred to.

"(c) *Reduction of the Co-efficient of Friction by Water.*—The co-efficient of friction of damp clay is about 1·0 corresponding to an angle of repose of 45°. The co-efficient of friction of wet clay varies from 0·25 to 0·31, corresponding to an angle of repose of of 14°-17° (Rankine). The effect, therefore, of water on a soft bed of shale is equivalent to lubrication, and doubtless this has occurred in the shales which underlie the dolomites in the cliff at Gohna. After the season of heavy rain which preceded the landslip, the mountain must have been saturated with water. The disastrous landslip at Naini Tal towards the end of the rains of 1880, illustrates this fact. The mass of slush forming the foot of the slip sloped at an angle of 15° up to where the old Victoria Hotel stood, and from there the drier *débris* formed a steeper slope of 25°. A similar illustration afforded by the well-known landslip region of Sout Devon and Dorset, between Sidmouth and Lym Regis. There the porous crutaceous beds resting i the impervious clay-beds of the lower Lias, Rhaet and Red Marl, and dipping gently towards the se have been pushed over the slippery wet clays by hydrostatic pressure which must have been only small fraction of the weight of the beds.

"2. SUBSEQUENT CHANGES IMPELLING STRAT IN THE DIRECTION OF LEAST RESISTANCE.—Tl direction of least resistance in this case is, of cours towards the gorge, and any sufficient impulse coul only be manifested by movement in that directio The smallest movement thus becomes a positi contribution to the final condition for a slip.

"(a) *Expansion of Products on Oxidation a Hydration.*—The sulphuric acid produced by tl oxidation of pyrites would under pressure and hi temperature, decompose the carbonates of lime a magnesia, and form either anhydrous or partial hydrated sulphates, which would expand on su sequent more complete hydration before final remov This action taking place in small cracks would gi rise to the production of a number of wedges, dislocate the rocks. Although I have mention this as one of the causes which brought abo disruption of the originally more compact rocks, should not imagine that in the present instance tl effects were very serious. Gypsum, the final produ of the action of sulphuric acid and water on carbona of lime, nevertheless occurs in illustration of tl statement.

"(b) *Changes of Temperature.*—The expansi accompanying the rise of temperature during tl summer can only be manifested in the direction least resistance, and as there is no tendency to retu on subsequent contraction during the low wint temperatures, the result is a gradual creep in tl direction of the valley. In the Garbwal Himalaya mountains of the height of those at Gohna are f some time covered with snow and frequently subject to a freezing temperature. The surface rocks at a rate will, therefore, suffer the usual effects of frost.

"(c) *Hydrostatic Pressure.*—From the upper ed of the slip the hill rises at the back to a height 11,109 feet—a rise of 11,109-9,620 = 1,489 feet half a mile. As the strata dip in this direction at slightly steeper angle than the surface slope, there every facility for rain water sinking through to exe a hydrostatic pressure due to a column increasi from 1,489 feet to about 1,489 + 5,000 = 6,489 fe in height. As the slip took place towards the end the rainy season there is every reason for includi this among the causes, which combined, broug down the side of Maithána hill."

Mr. Holland concludes his report by sayin that—

"It may be of interest to remind the gener reader of the fact that the folding of tl

Iimalayan range having continued to times eologically recent, if not still in action, there as resulted a condition of strain frequently manifestg and relieving itself by earthquakes, and of steep lopes with rushing torrents, frequently resulting in ndslips. When subsequently the inequalities of vel have been sufficiently reduced by denudation, e slopes will be more stable, rivers less violent, and e scenery tamer—a condition of affairs exemplified y the more geologically old fashioned peninsular ortion of India. Water, the great agent of denudaon, has by its chemical and physical action been the use of the landslip at Gohna."

Before the end of July all the arrangements hich had been ordered for the protection of fe and property were completed. A good eal of percolation was noticeable at the toe of e dam, but much of it was attributable to e rainfall on the dam. The area of the lake hen the water was level with the top of the am was calculated from the contoured map repared by Lieutenant Crookshank, R.E., to e about 37,000,000 square feet in round umbers, or say 1⅓ square miles, and the tal contents were roughly estimated at ,650,000,000 of cubic feet. This quantity is quivalent to a rainfall of 0·15 inch over the hole drainage area of the Alaknanda River, lculated from the point at which it enters e Ganges River, viz., 4,140 square miles.

The first symptom of the approaching colpse occurred on the 10th August. For some me past the water had been rising very eadily, owing to the rains which had comenced early in June and the melting of the ows, and on the 4th August it had reached ithin 82 feet of the lowest part of the dam. n the 9th August there was very heavy rain hich caused a serious slip in the down-stream ce of the dam, leaving an almost perpencular section some 400 feet high. The secn thus exposed disclosed a layer of stones the top, below which only pulverized rock s visible. Percolation, which was now very avy, was running in a considerable stream er the boulders of the former river-bed laid re by the slip referred to. This slip caused e death of a man called the Gohna Fakir, s wife and three children. The Fakir had rsisted in remaining in a very dangerous sition below the dam, though he had peatedly received orders to leave it. He d his family had twice been forcibly reved to a safe place, but had returned each ne. On the 11th August the first warng was telegraphed to all concerned intiting that the lake would escape within fifteen days' time; and this was followed by a notice that the lake was 50 feet from the top of the dam. In all 87 warning messages were despatched from Gohna. Percolation was still steadily increasing, On the 10th July it was calculated to be 50 cubic feet per second, on the 17th July 150 cubic feet, and on the 12th August 350 cubic feet per second. On the 22nd August Lieut. Crookshank issued the warning message that the lake was expected to escape within 48 hours. By cutting a very narrow channel 2 ft. 6 in. deep in the crest of the dam he expected to bring in the flood early on the morning of the 24th August, but owing to increased percolation and smaller rainfall than on previous days, the lake rose so slowly that it did not reach the bottom of the cutting until the afternoon, and as it was considered important that the flood should occur during daylight, the channel was filled up so that the over-topping might take place on the morning of the 25th idem. The lake water commenced to trickle over the dam through the cutting at 6.35 a.m. on the 25th August. At first the destructive action of the water was very slow, and the volume escaping from the lake over the dam did not exceed 200 cubic feet per second up to 3.30 p.m., at which time a thick mist descended and heavy rain fell preventing Lieut. Crookshank from taking further observations. But at 2 p.m. the percolation which had now increased to an alarming extent, caused a sudden cutting back of the dam on the down-stream side to within 1,000 feet of the overflow point. At 2.30 p.m. a message had been despatched down the line to the effect that the dam was cutting back, and that the lake was expected to commence falling during the night. The thick mist and heavy rain still continued to obscure the slip, and it was quite impossible to observe the action of the water on the dam. At 11.30 p.m. a loud crash was heard, and in spite of the mist and rain the air was filled with a fine dust which rose from the dam. On observing this Lieut. Crookshank went with the civil functionary, Palwari Mali Dasauli, down to the dam, and made a final inspection of its condition. It was then midnight. As far as he could ascertain the dam was completely breached, and the lake water was escaping through a rapidly increasing channel. The effect on the dam had already been very marked, and the upper surface where Lieut. Crookshank and the Palwari were standing suddenly sank some feet. At twenty minutes after midnight another warning message was sent down the line to the effect that a very great rush of water was being discharged from the lake. It was not possible to gauge the discharge owing to the thick mist which prevailed and the torrents of rain which were falling, nor could it be ascertained at what rate the lake was emptying. At 5 a.m., although the valley was full of mist and the light very scanty, it became evident that a great fall had taken place in the level of the lake, and the irrigation officers and civil authorities at Hardwar were warned to expect a great flood. The sides of the lake, after it had emptied below high-water mark, were waste and desolate. They were cracked and had slipped in many places, and were devoid of trees and vegetation, and an offensive smell rose from the ground which had been so long submerged. Below the dam the valley of the Bireh Ganga was filled up with huge blocks of rock, washed away from the landslip by the torrent, and it was found that at the gorge below Gohna the level of the bed of the stream had been raised about 234 feet. The discharge from the lake was still going on, but it was confined to the natural drainage of the river basin. In emptying itself of so large a part of its contents the lake had made a strong and substantial weir, composed of huge blocks of rock, tightly packed with boulders, and having a long gentle slope stretching far down the valley. The first rush of the impounded water commenced about 11.30 on the night of the 25th August, and by 4 o'clock on the following morning the lake level had fallen 390 feet, equivalent, in round numbers, to a discharge of about ten thousand millions of cubic feet in the space of four and a half hours. At Chamoli, a village some 13 miles from Gohna, the flood first began to rise at 11.55 on the 25th August, and the maximum height attained was about 160 feet above ordinary flood level. The abutments of the permanent bridge, a temple, the Dharmsala, Bazar and Dispensary, were completely washed away, and the bed of the river was raised about 50 feet with the *débris* deposited by the flood.

At Nandpryag, 20 miles from Gohna, the flood was first observed at 17 minutes past midnight, and the extreme height attained, over ordinary flood level, was 113 feet. The Suspension Bridge, the Bazar, Dharmsala and Public Works' Store were wrecked. At Karnpryag, 30 miles beyond Gohna, the flood arrived at 50 minutes past midnight, and reached its maximum of 130 feet at 1.45 a.m. Much the same damage occurred here as a Nandpryag. At Rudrapryag, 51 miles from Gohna, the flood was first noted at 2 a.m. and reached its maximum of 140 feet at 3.45 a.m. At Srinagar, 72 miles from the landslip the flood was first observed at 3.25 a.m., and at 4.40 it attained its maximum height o 42 feet above ordinary flood level. Here the damage done was very great. Srinagar is the principal village in the Garhwal district, and contains a population of over 2,000 persons It was once the capital of the Garhwal Rajas and there are some temples and a palace buil there. The entire village, the Tehri Raja's Palace, Dispensary, Police-station, and Dal Bungalow, were destroyed, and a thick layer o stones, sand and mud deposited over the area but owing to the timely warning there wa absolutely no loss of human life whatever Several small villages in the valley which were within the influence of the flood, were entirely swept away, not a vestige of them remaining but the inhabitants were fortunately able to escape with their lives and such of thei movable property as they could carry with them.

The flood commenced to rise at Hardwar 150 miles from Gohna, at 8.45 a.m. on the 26th August, and reached its maximum o 11 feet above the ordinary flood level at 11.3 a.m.

Between Gohna and Srinagar the average greatest depth of the torrent was about 140 to 150 feet above the river bed, and the average width in the upper reaches where the bank formed by two mountain sides are steeply scarped, was about 500 feet.

The average velocity of the flood over thi upper section of its course was about 26 fee per second.

In the stretch between Gohna and Chamoli however, the figures must have been much higher. The greatest depth varied from 26 feet at the gorge immediately below the dam to 160 feet at Chamoli, and the velocity wa probably not less than 40 feet per second. A Srinagar the valley opens out into a large amphitheatre less than a mile in width and from three to four miles long. Here, therefore the level of the flood did not rise much above 50 feet over the bed of the river.

Immediately below Srinagar the valley contracts suddenly at the Jakhni Gorge, and from there down to Luchman Jula the bed is narrow and the sides precipitous. The effec of this conformation was that the flood wate after opening out at Srinagar was abruptly ontracted at Jakhni, and a back water was et up which took the form of a strong uptream circling current. The effect of this orrent of rushing water swirling furiously in he darkness of the night close below the bservers was terrifying, and many of the nhabitants who had been securely placed in emporary shelter huts above the danger limits led in fear still further up the mountain ides.

The observations of the rise and progress of he flood were made by means of lanterns laced on masonry pillars, which, as has lready been mentioned, were erected at 10 eet intervals at each of the observing stations. Vhen intimation was received from Gohna of he approach of the flood the lanterns were lit, nd as the waters rose the lanterns were vashed away and extinguished and the time ntered in the observers' note-book. The bservations were not so complete as could ave been wished, owing to the flood having ccurred during the night, but they still afford seful information.

The canal authorities at Hardwar, under he direction of Mr. R. A. Cordner, M.I.C.E., uperintending Engineer, Public Works epartment, had taken precautions for he safety of the headworks at Maiapur in nticipation of the Gohna flood, as any serious lamage to the works, entailing the closure of he canal for any length of time, would have een a very great disaster to the country, of vhich so large an area depends for its irrigaion in the dry season on the canal. The nost important work to protect was the canal ead at Maiapur, which is situated at a short listance below Hardwar, as a heavy flood ursting into the canal might not only carry way the head works but also seriously injure he great torrent works and falls lying between t and Roorkee. The following are the proective works which were carried out:—

(*a.*) A massive crate bund filled with heavy oulders, having its top level with the platorm of the large sluices of the Maiapur dam, vas carried from the latter along the back of he revetment wall joining the dam and canal, nd terminating in a mound on the right lank of the canal head.

(*b.*) A bund or embankment from the crate und to the Kankal road, until a point on the ising ground was met which was level with he top of the crates. The object of this mbankment was to protect the headworks rom being outflanked by the flood.

(*c.*) Strengthening of the canal head-gates to enable them to resist the increased head of water which would be against them.

(*d.*) Removal of parapet of canal-head on down stream side, so as to give a free flow to such water as might pass through the crate bund.

(*e.*) Subsidiary boulder bunds connecting ends of land-wings on down-stream side of canal-head with high land to prevent outflanking.

(*f.*) Completely closing portion of diversion channel.

(*g.*) Where the canal passes through lowland in the ninth mile, and immediately above the embankment leading to the Solani Aqueduct in the sixteenth mile, the canal banks were lowered, so that in the event of a heavy flood bursting into the canal at Maiapur, these openings would act as temporary escapes and afford relief, and possibly aid in saving the great masonry works on the canal above Roorkee from destruction. Orders were also issued regarding the timely removal of members of the canal establishment from situations likely to be affected by the flood; and detailed instructions were given with reference to closing the canal-head and opening the regulating dams at Hardwar, Maiapur, and Dhanauri, when the bursting of the Gohna dam was imminent.

At 7.22 in the morning of the 25th August, Mr. Cordner received a warning telegram from Gohna, and at 8.45 a.m. on the following day the river at Hardwar began to rise. The revetment walls of the Hardwar dam were shortly topped, and it was evident that considerable damage was being done to the work. The marginal bund, protecting Bailwala island, was also topped, and a large body of water passed over the island, some of it breaching into the diversion channel. Four, out of the seven, large sluices of the Maiapur dam were soon put out of action by blocking, due to great trees and masses of *débris* brought down by the flood, and some water broke into the canal through the head, though the crate bund was not topped. The flood continued rising till some time before noon, when, to the intense relief of the spectators, it steadied and soon began to fall. Heavy floods had passed down the Ganges in July and the early part of August, and the *débris* brought down by them had blocked some of the large sluices of the Maiapur dam, and it was quite impossible to clear them before the flood of the 26th August as the water had not subsided sufficiently to enable the *débris* to be got at. It was most fortunate, however, that the Gohna flood occurred at a time when the river was lower than any level recorded for the previous thirty days. Had the Gohna flood come down on top of one of the very heavy floods that occurred in the previous thirty days, the canal authorities might have had to face a very grave disaster. As it was, the damage done to the canal works was estimated to be of the value of Rs. 40,000, and the cost of the protective works amounted to Rs. 10,000 in addition. In part of the town of Hardwar itself, which is situated on the left bank of the Ganges, the flood is reported to have stood at a depth of 6 feet in the main streets. The native overseer who was stationed at Hardwar to take observations of the flood reported as follows:—

> "The people at Hardwar, Kankal, and Jwalapur did not believe, when they were informed to escape within 48 hours' time. They were laughing, rather in pride, that only the divine can know about such flood, and time when it would come, and whether dangerous or not. But, after all warnings given to them repeatedly, they saw the apprehended flood horribly passing before their eyes. And all of them were to lament if it had been raised ten feet more, to have swept away the whole property, &c., throughout Hardwar. When they saw that the flood was decreasing from 12 a.m. of 26th, they heartily and most sincerely offered thanks to the Government for their safety in all, and wonderfully admired on the arrangements made by the Government so accurate and correct."

The total loss to Government owing to the destruction of bridges and buildings along the valley of the Alaknanda to Hardwar, has been estimated at about Rs. 1,00,000. The cost of the protective measures undertaken, including the erection of the telegraph line 149 miles in length with offices and hutting of officers, amounted to about Rs. 90,000, and the expenditure by the Irrigation Department for protecting the works at Hardwar and repairing damages caused by the flood, was about Rs. 50,000. The total outlay incurred by Government in connection with the landslip may, therefore, be placed at Rs. 2,50,000. No estimate has been made of the loss caused to private individuals. The first object which Government had in view in dealing with this unique case was to efficiently protect the life and property of the people from the effects of the great flood which was certain to follow on the bursting of the lake, and in carrying out this humane policy no expense was spared. At the same time the greatest care was taken to work as economically as possible, and to prevent any waste of public money. Ever measure was closely scrutinised by the official to whom the direction of the operations wa entrusted, and no work was undertaken unles it was proved to their satisfaction that it wa absolutely necessary. From beginning to end economy was strictly enforced in all directions

The success which attended the operation has been even greater than was anticipated That the enormous volume of water which wa suddenly hurled along the valley during the dead of night, raising the height of the rive considerably more than 100 feet in some place above the level of ordinary floods, should have passed away without, so far as is known, causing the loss of a single life is a matter fo sincere congratulation; and no higher testimony is possible to the efficiency of the protective measures and to the care and precision with which they were carried out than this fact. That the people themselves recognise and are grateful for the consideration which they received in the precautions which were taken for their safety cannot be doubted, and the recollection of the beneficent care shown by Government for the preservation of their lives and the protection of their property must ever be fresh in their memories.

It is impossible to praise too highly the services of the Staff more immediately engaged on this important work, or to thank them sufficiently for the efficient manner in which they carried out the trying duties imposed on them. One and all worked with an earnestness which guaranteed success.

The construction and working of the telegraph line was an undertaking which taxed to the utmost the energies of the telegraph staff. The work was of a very arduous nature, owing not only to the extremely difficult country through which the line had to be taken, but also to the almost entire absence of the necessaries of life, most of which had to be imported from the plains. But, as experience has repeatedly shown, the Telegraph Department of the Government of India can always be relied on to carry out in a thoroughly efficient and satisfactory manner whatever duty it may be engaged upon, whether in the operations connected with an army in the field or with such as are described in this paper. The large rocks and *débris* of the landslip have been so consolidated and packed by the flood that they now form a massive and solid dam, which is not likely ever to be disturbed, and a permanent lake has probably been established at Gohna.

The dimensions of this lake are as follows:—Greatest length about 3,900 yards, average width 400 yards, and greatest depth 300 feet. It may be that in time Gohna will become a pleasant resort for the weary traveller from the plains, and that boats will sail upon the lake. But it will be long before then!

DISCUSSION.

Mr. A. R. **Binnie**, M.Inst.C.E., said the paper gave an interesting and instructive narrative of a unique experience. Realistic as was the description given, probably only those who were acquainted with the very sad consequences which had too often followed upon the sudden escape of water in immense volume down steep slopes, would thoroughly appreciate what such a catastrophe might mean. The Huddersfield calamity, it would be in everybody's recollection, caused the loss of hundreds of lives, and many thousands of pounds' worth of property. The disaster at Sheffield, in 1864, was also memorable, when the bursting of a reservoir caused great devastation, and the loss of from 400 to 600 lives. In France, too, we had recently had an instance of enormous destruction which might be caused by a great dam suddenly giving way. In those cases, however, the catastrophe occurred suddenly. Fortunately, that was not so in this instance, where the dam 900 feet in height resulting from a landslip in a narrow valley had to be watched continually until the final bursting so accurately calculated nine months beforehand, and he could not but admire the courage and foresight of the Government in not attempting to palter with the thing by merely cutting a channel for the escape of the water shut in. To have done that would have been merely wasting money. The natural forces at work, which had to be dealt with were far too large to be overcome by anything of that kind, and the wisest course was to adopt the preventive measures which were taken against the loss of life otherwise inevitable. All who had listened to the paper must have felt that the operations for that purpose were carried out with the greatest ability and foresight by the officers of the Public Works Department in India. Colonel Pulford and Lieutenant Crookshank might congratulate themselves upon having had to direct the operations necessary to contend with one of the greatest effects of natural forces short of an earthquake which any engineer could possibly have to cope with. He begged to offer his sincere thanks for so interesting and valuable a paper to its absent author.

Mr. **Theodore Carter** was interested at the suggestion by the native mentioned, for dealing with the impending catastrophe by the employment of tubes for carrying off the water. But it was only the old syphon idea, and syphons had been largely used in this country. On the Middle Level Drain which drained Bedfordshire and that portion of the Fens falling into the Ouse, there was a large sluice or dam near Lynn which gave way owing to the sinking of the ground, and when the flood tide came up it ran along the canal for a considerable distance. The Middle Level Drain was only constructed to carry away the quiet drainage water and was not able to cope with the strong flood tide which passed up the Ouse. The consequence was that the sluice gave way some 300 or 400 yards up, and the country to a considerable extent was for some time flooded. Naturally the people about the place were very anxious about it, and they managed to put a large dam across, some 300 or 400 yards from the sluice, where the Drain emptied into the Ouse, so that the tide should no longer get up and break away into the surrounding country; but they found that in doing that they had shut off the water wanting to get away from the inner districts. There was a discussion in the Press about it at the time—it was some 30 years ago—and the matter was ended by the fixing of large syphons over the dam, which were worked successfully for many years, always, of course, when the tide was at a lower level than the water in the canal. He visited the place again in 1869, purposely going out of his way to see those syphons—there were five or six of them—working over the dam. They were of large size, some three or four feet in diameter, and were working very successfully. Whether or not they were working now he could not say, for he had not been there since.

The **Chairman** moved a vote of thanks to Mr. Glass for the effective manner in which he had described the circumstances attending this enormous landslip, and the operations which had been necessary for coping with it. The Public Works Department of the North-Western Provinces and Oudh was at that time under Mr. Glass, who was chief engineer; and on him rested the main responsibility of advising the Government as to the measures which ought to be carried out. Colonel Pulford was the man who went to the spot, and diagnosed the case. All listening to Mr. Glass's paper would acknowledge that he must have formed a very accurate estimate of what was likely to occur, and had also decided upon the best method of dealing with it. To him, and to the officers under him, was due entirely the credit for the measures taken, and for the successful manner in which the work was carried out; but, at the same time without the valuable assistance of the Telegraphic Department nothing could have been done. It would have been of no use devising the measures unless there had been efficient telegraphic means of advising when they were to be carried out. On the Telegraphic Department a great portion of the work had really fallen. The difficulties under which it had to be carried on were not to be easily realised. No one from looking at the pictures shown to the meeting could imagine the heat and discomfort of those valleys in the hot season. They were exceedingly sheltered and shut in; everything had to be carried up there and water was only to be procured with difficulty. There the telegraph staff had to remain for some months at the risk of their health, and some of the officers, it was to be feared, even lost their lives during the operations. But in the end the work was carried out most successfully, and none of the officers engaged in it grudged the labour and hardships which they endured in carrying out safely the great work which they had been able to achieve for the safety of the lives and property of the people whom England had undertaken to govern.

The vote of thanks to Mr. Glass was carried unanimously.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 25, 1896; LORD BELHAVEN and STENTON, Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Henderson, George Thompson, 7, Billiter-square, E.C.
Macaulay, Frederic Julius, London and South-Western Railway, Waterloo Station, S.E.
Rhodes, John William, 7, Mitre-court-chambers, Fleet-street, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Crowe, Sir Joseph Archer, K.C.M.G., C.B., 28, Avenue du Trocadero, Paris.
Pye, George Gard, 42, Brodrick-road, Upper Tooting, S.W.

The paper read was—

OUR FOOD SUPPLY, AS AFFECTED BY THE FARMING OF THE FUTURE.

BY PROF. JAMES LONG.

Of all great industries agriculture is the one which suffers most as the world progresses. There is no civilised country in which agriculture is pursued which has not felt the severe pressure of the competition which is as ruinous to the new as it is to the old producer. Man is a born tiller of the soil, and he continues to fly to the land in new countries in spite of the precarious character of the subsistence it affords, in order to escape servitude in old countries, and, as he fondly supposes to live a life of freedom, although in reality he becomes a slave to an idea. There is a question involved in the agricultural problem which is worthy of close consideration. I do not pretend to discount the effects of the prodigious
losses which the agricultural interest h
suffered, but I am tempted to suggest in pas
ing that our position to-day has been measure
rather with the period of unexampled pro
perity during the middle of the prese
century, than with our less pretentious a
less profitable previous history. The agricu
turist is entitled to participate in the comfor
and, if you will, the luxuries of modern civi
sation, and comparatively recent succe
enabled him to reach an advanced standard
this direction; but success in the acquisiti
of property, or in the enjoyment of life
unnecessary favours are not characteristic o
life on the farm, nor are they actually necessa
to health, to happiness, or to prosperity.
have a greater respect for agriculturists th
for any other body of men, and none deser
more at the hands of their fellow countryme
for he who devotes his life to the soil virtual
renounces his chances of so-called prosperit
and devotes himself to the production of fo
for the use of mankind. Such a man, howeve
prospers when he commands, as the fruit
his labour, the necessaries and the comforts
life, and his cup would be full if he were
possession of the soil he tills. What t
world calls success—the acquisition of wealth-
too often means both moral and materi
failure in the next generation, for me to desi
to see the farmer achieve it.

We start then with the assumption th
agricultural success is, the world throughou
very modest in comparison with succe
achieved in commerce and the general wal
of life. In twenty-five years we have passe
from prosperity to adversity—from old wor
farming to methods which are being inculcate
by scientific teaching, and in proportion a
those methods are improved and adopted, s
shall we convert the failures of the end of th
nineteenth century to the successes of th
twentieth.

Let us glance at the position and practic
of to-day so far as it is typical of the pas
Our farmers have been reared in a severe
practical school: they have learned the manu
processes of the farm, followed their fathers t
market and sale, and adopted the systems
the district in which they lived, all admirabl
practices in their way, but entirely insufficien
Of scholastic education many have receive
very little, of scientific instruction absolutel
none. At a time when almost every acre of arabl
land is losing money, farms are still too big fo
manipulation, for stocking, and for manuring
The labour of the farm is distinctly inferior t

what it was in better days, while the wages aid are higher. Rates, taxes, and tithes are it of all proportion to the value of land and ie retnrns of the farm. In twenty-five years ie profits assessed to the Income Tax have sen, on a five years basis, from £14 to £18 5s. ır head of our population, and yet agricul- re is almost bankrupt. We grow grain crops an average of about £5 per acre, although ore often than not this sum is below the cost production. Within a radius of 20 miles of ondon, thousands of acres produce hay which alises no more than 50s. an acre, although ithin the same area, soil of the same charac- r produces under glass culture, crops worth om £500 to £1,000 an acre. We produce ass, roots, and forage crops for our cattle and ieep, and these enable us to send meat into ie market to compete with some success gainst imported carcases from other countries, though at prices which are but little above e cost of production, together with milk hich is now realising the munificent sum of d. to 5½d. per gallon on the farm. Many of ır farmers manufacture butter and cheese, though prices have been driven to starvation int by increasing imports from abroad.

To some extent new methods are adopted in e dairy, but they will give place to others of a ore advanced character, which will enable th quality and quantity to be increased. We oduce the finest horses in the world, but ose most in demand are now largely supplied breeders of other countries. Our stock is d by the aid of roots, grain, and pulse, but the future we shall be able to diminish the o rata imports. The farming of to-day is oduction from hand to mouth, without capital, th a constantly depreciating soil, diminishing ock, and prospective ruin. It is clearly re- gnised that so long as it is possible for every lditional farmer in Canada and the West to ovide bread for 300 people upon every addi- nal 100 acres of virgin soil which he adds to e world's great farm, so long will prices main low and our British systems of agricul- re remain at a disadvantage. There must, wever, be some articles of home produce, ich, on account of their perishable nature or eir superior quality will realise better prices our markets, and in which the demand will crease with the growth of the population, and ich it will be impossible to grow to an un- nited extent in consequence of the limited ea of our soil. It is in this direction that riculturists will gradually feel their way, led and supported by economic methods which science and practice are constantly suggesting, and by new conditions which it will be the function of the State to provide. With the vast corn areas of new countries before us and the self-denying character of the people who occupy them, we cannot hope that grain will continue to be a prominent article of our farm produce, but we can continue to provide live stock for meat and for export, milk for our congested population, butter and cheese of the primest quality for the thousands who will continue to pay for it, malting barley for our brewers—when Parliament has afforded us the opportunity by discriminating between barley-malt and sugar—poultry and eggs, fruits and vegetables for sale at our doors, and even hay and straw, where maximum crops of these materials are obtainable.

Let us see then what are the conditions under which these articles may be profitably produced in the future.

1. *Intensive or Garden Farming.*—Apart from the influence of seasons, upon which the yield of crops so much depends, the soil, when thoroughly tilled, is capable of immensely increasing the crops we produce. Among modern crops may be quoted 100 bushels of oats, 100 tons of mangels, 5 tons of hay, 23 tons of potatoes, 40 tons of maize forage. If these crops are exceptional, the soils in which they were grown were not exceptional, although they were suitable, and cultivated as well as they could be. Intensive farming involves more labour and thorough knowledge of the work if it is to succeed.

2. *Smaller Farms.*—Apart from the large areas of land upon which intensive farming is impossible on the lines indicated above, there cannot be much doubt about the fact that large occupations are not conducive to the most economical results. Every yard of land should be fully cropped, but on large English farms a tenant cannot examine the whole of his land—in many cases he cannot even see it once a week. Tillage is often perfunctory, and always more or less imperfect, while adequate manuring is impossible. The condition of land depends upon the weather; but on a large farm operations must be performed to save crops, and consequently seed is often sown, and crops harvested, under the most adverse conditions, with the result that serious loss is involved. A small area thoroughly farmed will return a much larger crop per acre than a large area, farmed under usual conditions, and a much more certain and substantial profit.

5. *Security for Improvements and Free-*

dom in Cropping and Sale.—No doubt the present Parliament will pass a law dealing with these questions. It is, however, notorious that farmers, although it may be contrary to their immediate interest, decline to expend capital in high farming under existing conditions. They fear that their rent may be raised upon their own improvements, and now that grain cultivation is so unprofitable, and the old rotation system of cropping obsolete, they very properly ask to grow and sell what they please, conditionally, of course, upon the maintenance of the condition of the land.

4. *Extended Ownership.*—The existence of so much derelict land in England points to the necessity for its absolute possession by skilled tenants. Owners cannot let it in its present sad state; they apparently cannot afford the expense of bringing it back to tenantable condition. If it were obtained upon a convenient system of deferred payment, very few years would elapse before it would become as productive as of old. There are thousands of men only too ready to embrace such an opportunity, men who continually swell the ranks of emigrant farmers to the far West, where the conditions of life, as of farming, are much more severe. I suggest Government loans at 3 per cent., the repayments—in advance—to be extended over 20 years, 80 per cent. only being paid over to the seller, who would receive 3 per cent. on the balance.

5. *The Improvement of Grass Land with the Object of Increasing the Quality as well as Quantity of the Herbage.*—Practice following experiment has demonstrated the possibility of largely increasing the value of grass land. Herbage is chiefly composed of grasses and clovers. Its feeding value is increased by the presence of the clovers, but in the majority of our grass fields—meadow and pasture alike—the clovers are lamentably deficient, and in hay they are too often entirely absent. These plants respond to the mineral manures, whereas the manure produced from them encourages the grasses. Liberality, skilful management, and judicious manuring in grass farming, will enable our farms to carry more stock.

6. *Improving Arable Land.*—In Germany great attention has been paid to the improvement of sandy and peaty soils by the employment of artificial manures, the cultivation of special crops, and subsequent green manuring. This process involves expense, but it is much less costly than the system of draining which prevailed 20 years ago; it is equally valuable in reclaiming, and it would be gradually adopted by farmers occupying their own land. There are other soils which, on account of their dryness, are but slightly productive. It has been recently demonstrated in Germany that deep-rooted plants, which, like the lupin, seek for moisture far below the subsoil, not only provide green manure, but leave numerous tiny channels behind them, into which the roots of a succeeding crop will find their way, and thus obtain the moisture required to enable them to produce an excellent crop. There are too many cases in which fields refuse to grow crops, but there is strong foundation for the belief that this is owing to the absence or insufficiency of a soil organism, such for example as is known to be necessary for the utilisation of free nitrogen by the papilionaceous plants of the leguminous family. In France experiments have shown that by inoculating an infertile field with soil from a field, fertile to the crop which is to be grown, full results have been obtained. This opens up a wide question, but one which by experiment, on the now numerous experiment farms, will not long remain undetermined, and which will I hope result in still greater aid to farmers.

7. *Increased Value of Farmyard Manure.*—It is yet too early to declare that any method has been discovered which will prevent the loss of the nitrogen of manure which occurs in farm practice. It is well known that nitrogen—which is worth at least 6d. a pound to the farmer, and which is much the most important constituent of farm manures—is lost during the exposure of the manure to the atmosphere, but this loss is believed to be slight in comparison with the loss which occurs within the soil, where, according to Wagner's recent investigations, it is liberated in a free form and returned to the atmosphere. This liberation, we are told, is the work of a soil organism—the anti-nitric ferment. From Wagner's work I glean that when means have been discovered to prevent this loss, each ton of farm manure will, so far as its nitrogen is concerned, be worth as much as three tons at the present time, and this must tell largely indeed in favour of increased production.

8. *Reduction in the Cost of Production.*—In the future I believe the cost of farming will be diminished in (*a*) the purchase of manures; (*b*) the purchase of stock foods; (*c*) the introduction of labour-saving machinery.

It is scarcely possible for a farmer to produce sufficient manure to adequately manure his farm. Those who can afford it, purchase artificial fertilisers, chiefly comprising the highly expensive, nitrogenous, and the phosphatic and potassic manures. I believe that in the near future farmers will be enabled to utilise atmosphere nitrogen to such an extent that the purchase of nitrates and sulphates containing nitrogen will be unnecessary. Even now, a great deal can be done in this direction, and the suggestion applies to food equally with manure. The most concentrated and valuable of the bulky crops of the farm are the familiar members of the leguminous family. These plants are varied and adapted to different soils, and all, more or less, respond to mineral manures and lime. They enrich the soil in nitrogen, as well as the manure produced by their consumption, and their increased cultivation will proportionately diminish the necessity for the purchase of nitrogenous manures and foods. The cost of labour is a growing difficulty, especially as farm labour is less efficient than formerly, the best of the young men going into the towns. In the west of Canada the cost of the operations of the farm is less than with us, in consequence of the introduction of ploughs, harrows, cultivators, and drills capable of covering three times the area covered per day in this country; while the reaper has now been so much developed, that the corn is cut, threshed, and bagged at one operation. There is great scope for improved implements, especially for use on level and large fields.

9. *Utilisation of Town Manure.*—In the interest of public health local bodies are accustomed to waste a material of high fertilizing value. The loss which is occasioned is only in part covered by the employment of imported cattle foods and fertilisers, but if by the developement of scientific methods, the use of these materials is abandoned, as they may be when town refuse is utilized, it follows that there is urgent need of some system, which, while securing the health of the people from danger, will place it at our disposal.

10. *The early Maturing of Stock for Slaughter.*—General improvement in the breed of our meat-producing stock will, as it does now in the few cases in which early maturity is an accepted principle, decrease the cost of production. Cattle which were formerly fed for 3½ years, and even longer, can now be fattened for the butcher under two years. As Mr. Turnbull has pointed out, the difference in value between a well-fed, well-bred bullock and one which is coarse and fat, is 7s. 6d. per cwt. and 75s. upon an animal weighing 10 cwt. The food consumed is more economically utilised by well-bred animals, and in order to breed and feed with profit it is eesential that such animals should be generally produced. Until they have become general we cannot say that we have got to the bottom of farming.

11. *The Improvement of Dairy Cattle.*—It is a recognised fact that improvement in the quality of milk is obtained by selection. I have estimated in an article in the *Nineteenth Century* that our 3,925,486 cows, assuming that 85 per cent. are in milk, produce 1,401,398,880 gallons, or 420 gallons per head per annum. Such a return is unworthy of our reputation. In the future this average will be largely increased, but if it were increased by only 20 per cent. the home production would be augmented by 280,000,000 gallons. On the other hand the quality of the milk used for butter and cheese manufacture (917,000,000 gallons), is much below a practicable standard. It could be increased by careful selection, as it will be in process of time, by at least 10 per cent. of solids, representing over 20,000,000 lbs. of butter and 30,000,000 lbs. of cheese.

12. *Prevention of Losses of Live Stock by Disease.*—I have had practical experience of the losses to which farmers are subjected from contagious diseases of animals. The country is not alive to the fact that tubercular disease, which is prevalent among cattle—and to some extent among pigs throughout the most populous districts of our country—is communicable to man; how therefore can we expect legislators, who will not protect their own lives against the direst of all diseases, to protect farmers against pecuniary loss. It is within the power of Parliament to materially diminish the losses from contagious diseases of almost all kinds, and in the future, when science has indicated a simpler and cheaper method than we possess to-day, the work will be done and millions will be saved.

13. *Extension of the Smaller Industries (Poultry Breeding and Fattening, culture of Fruits and Vegetables of the higher class).*—So long as we are content to pay £2.750,000 for apples and other fruits produceable in this country, £1,750,000 for potatoes and onions, and more than £1,000,000 for other vegetables, so long shall we have a margin of undeveloped producing power. In a smaller degree the remark applies to poultry and eggs, for, with the organisation of a rational system, all the articles of food can be produced at home. Just as many of our people die prematurely for want of the simplest technical

knowledge, so are many brought to the verge of starvation.

There are other questions under investigation at the various agricultural experiment stations which will ultimately assist in reducing the expenses or increasing the returns of the farm, and when the new generation of agricultural scientists arises, new questions will also arise and new discoveries be made which will enable the occupiers of land in these islands to cultivate the soil with still greater advantage.

So far then from believing that our imports of food will necessarily increase pro rata with the growth of our population and our home production stand still, I am of opinion that we shall be equal, for a considerable period, to the production of increasing quantities of those foods, such as fresh meat, bacon, milk, poultry, fruit, and vegetables, which we are still likely to grow upon the farm. Our people obtain a more liberal diet than was formerly possible. In twenty years our consumption of imported fresh meat has increased from 2 lb. per head to nearly 12 lbs. It is not long since our annual consumption of meat of all kinds was 70 lbs. per head. At a recent date it was 124·8 lbs. Twenty years ago the butter and margarine imported amounted to 5 lbs. per head, it has now reached 10½ lbs., and yet we have produced a great deal more. During the next few years I do not anticipate any marked improvement in agricultural prosperity—modern legislation and the exercise of greater skill will probably do no more than enable us to hold our own against the still lower prices which may be expected in almost every department of farm production. The crops and stock of the Colonies, America, Argentina, and the older countries of the world will continue to be poured upon our shores, but there are prices below which men cannot sell, and having touched bottom we shall be left with a market which, though smitten nigh unto death, will suffice to enable agriculture to exist, until, having gradually emerged from the severe ordeal through which we are passing, we shall rise to a more prosperous condition and face the music of the world.

It is probable that in 25 years our population will have increased by 10,000,000, this, alone, means an increased requirement of 130,000,000 gallons of milk, which, at the present rate, it would require 300,000 cows to produce, or sufficient to maintain 15,000 twenty-cow farmers. It also means, assuming the same quantity of home-grown meat is consumed per head, that 500,000 more fat cattle, ar
2,500,000 sheep will be required annually,
about 25 per cent. of the numbers which
now slaughter, and still a margin would rema
for the *pro rata* increase of the import
What applies to these foods applies equally
minor products. It therefore depends entire
upon our capacity to compete with the wor
whether we ultimately succeed or not. F
myself, I have every faith in the future. I r
gard the present period of tribulation as
experience of transition, and, for the reasons
have given, I believe that our growing pop
lation, our tendency to consume more and mo
meat, milk, and butter, and the better min
products per head, and our preference for th
superior quality, which is represented in hom
grown produce, will provide the farmer wi
that expanded market which, as a matter
necessity, he will endeavour to supply.

DISCUSSION.

Mr. S. B. L. **Druce** thought they might congratula
themselves on the hopes expressed at the conclusi
of the paper, and those interested in farming must f
gratified when a gentleman who had such great expe
ence in agricultural matters as Professor Long co
sidered that we were now merely in a transition sta
and that we should gradually emerge into a more pro
perous condition. He must say that during the last
years there had been very little prosperity connect
with agriculture, and the music of the agricultu
world had been of a very sad and sombre charact
On one point his experience rather differed from th
of Professor Long, viz., as to the superiority of sm
farms; for it went to show that the English farm
had done better, and was likely to do better wi
large farms than small. On a small farm there w
more loss and waste, and the capital employed w
likely to produce a better return from a large fa
than when spread over several small holdings.
farmer, like a manufacturer, was able to direct a
overlook a large area quite as well as a small o
and when he had only a small farm his time w
often wasted. He believed this was alw
the case except where the farm was so sm
that the farmer himself, with his wife and grow
up sons, was able to perform all the operati
required. Once let the small farmer, whet
tenant or owner, have to employ labour, and he w
placed in a position where he was far more likely
lose than gain. Then there was the important po
of the buildings, which was a serious difficulty at
present time. If the large farms of England a
Scotland were cut up into small holdings, n
buildings would be required. You must h
certain buildings on every farm, large or sma

at present you have one or two sets of buildings on a farm of 500 or 700 acres, but if that farm were divided into farms of 100 acres, each one would require buildings, and that meant a considerable capital outlay. Where it was to come from he did not know, and, allowing for interest upon it, he feared there would not be much chance of profit from the small farms. A similar remark applied to the suggestion that there should be extended ownership of land. It was a remarkable fact, as he believed, that both in the past and present tenant farmers did much better than occupying owners, and he could not but think that it was reasonable it should be so. The capital at the command of the farmer was generally limited, and in his opinion it was much better expended on the cultivation and stocking of land than on the purchase of it. At present the landlord was a sort of partner in the enterprise, and provided as part of the capital the land upon which the operations were carried on, for the use of which capital the farmer paid a very small per-centage indeed. He did not think the interest paid on the capital value of agricultural land, including the improvements made by the landlord, was more than 2½ per cent. to 3 per cent., which was a lower rate than capital could be obtained for in any other business. He was glad to hear the recommendation of farmyard manure, to which he was old-fashioned enough to attach a very great value, and he thought all farmers should endeavour to make more and more use of it. Its use, not its abuse, was one of the chief elements of success. He agreed that the high cost of labour was a very great difficulty, and he feared that it was a growing one. Only a short time ago he was in hopes that it was not so; that in fact, it was not so great as it was 15 or 20 years ago, but he was bound to say, from recent information and observation, that Professor Long was perfectly right in speaking of it as a growing difficulty. It might be said, and with truth, that exactly the same argument was used years ago, as to the best young men going to the towns; but the process was still going on, and the time had now arrived when the improved education given to the children of agricultural labourers was beginning to tell, and it was almost incontrovertible that the boys and girls who received this improved education were very reluctant to undertake farm labour. The girls did not care to go into service in farm-houses and learn their duties in the dairy, and the young men were always endeavouring to get either into the towns, or into service on the railways or into the police. During the five years which had elapsed since his father died, in a village in Oxfordshire, not one had passed in which he had not received one or more personal applications from the sons of labouring men in the village, asking him to help them get situations on the railway, and if this was his experience, what must be that of gentlemen occupying far more prominent positions. The introduction of more labour-saving machinery had been referred to, and no doubt in the past that had been of great assistance to the farmer, but he rather ventured to doubt whether it had not reached its limit in England. They had improved ploughs, drills, harrows, and thrashing and winnowing machines, and he did not think they could go much further. He did not believe that a reaper which would cut, thresh, and bag corn at one operation would have much scope in England; because it was not once in a hundred times that corn was fit to thrash directly it was cut. It might do in a dry climate like Canada or the States, but in England, and still more in Scotland, he feared it would tend to loss rather than gain. He concluded by thanking Professor Long for his paper, and especially for the hopeful prospect he held out to the farmers of the future.

Mr. J. S. Neville agreed with the last speaker that it was exceedingly problematical whether the cutting up of large farms into smaller ones would be beneficial, for the reasons he had stated. It would throw a heavy burden on an impoverished class, that of the landowners. The expense for labour was the great evil of which the farmers complained—the one bill he could not get rid of if he cultivated his land properly. If more machinery were introduced, where was the capital to come from with which to purchase it; and, on the other hand, if you diminished the number of labourers required, there were complaints of the people being driven into the towns. Farmers complained that boys who formerly took to agriculture, now made efforts to get into other occupations, and particularly to become clerks, and that was no doubt due to compulsory education. Not only were the children so educated that their minds were attracted to other employments, but they were kept at school until a certain age, and, consequently, did not enter on farm labour early enough in life to acquire a taste for it. It seemed to him, on the whole, that Prof. Long, advocated turning farms into market gardens; the land was to be cultivated very highly, with the aid of machinery, manures, and so on; but, again, the question arose, where was the money to come from? From all he could see, the only hope for agriculture in the future was to adopt the co-operative system, such as was carried out in Denmark in the manufacture of butter and cheese; and he believed also in Australia. Except in this way, he saw no hope of agriculture becoming again a paying industry, and if it were not a commercial success, it must eventually cease, and we should have to depend entirely on foreign sources for our food supply.

Mr. R. H. Rew said he was much interested in the question of co-operative farming, which, he believed, held out most hope for the future. It was only fair to point out, in answer to the criticisms which had been passed on the suggestion for sub-dividing large farms, that it was also suggested in the paper that the Government should advance money to the landowners to enable them to undertake such operations.

It was obviously by some such means that the system could be carried out. He agreed to a large extent with Mr. Druce as to the desirability of increasing the use of farmyard manure; but, however desirable that might be, it was rather difficult to urge it upon farmers, in view of the fact that the cultivation of arable land was decreasing year by year, and therefore the amount of straw must necessarily decrease also. The paper was partly of an optimistic and partly of a pessimistic character. It was discouraging, in so far as it intimated that we had not yet touched bottom in the matter of prices; and, if farmers had to look for further reductions, he feared the faint hopes of prosperity 25 years hence would hardly keep up their courage. At the same time, Professor Long was an optimist, in holding the view that England could still keep her own in the face of foreign competition. He must say, however, that recent figures hardly tended to encourage that belief; but he hoped Professor Long was right. It must be remembered that the mixed farming of this country was more intensive in its results than that of any other country in the world, and produced more per acre, the only exception being Belgium. Then it was rather curious, that while Professor Long advocated more intensive farming—putting more into the land—he also looked forward to the time when they would be able to reduce their expenditure on artificial manures, which seemed, at first sight, rather contradictory. With regard to the burning question of labour, this had been a difficulty with farmers, as Mr. Druce said, for the last fifteen years or more; but while there was no doubt the tendency for the young men to flock into the towns, there was also a reflex action, to a certain extent, and some were now going back to the country. He had known instances of men who went away from the country as youths, tried town life, and then went back and became some of the most valuable labourers on a farm. He feared the proceedings in Parliament that day did not much encourage the hope that much assistance would be obtained from the Legislature in the direction of encouraging the growth of English barley for malting purposes.

Mr. **Green** said he must support the author's view with regard to small holdings. He came of an old yeoman family, whose experience had been that when farming was profitable the acreage was comparatively small. So far as his inquiries had gone, and he had pursued them for some years, he had come to the conclusion that the period of greatest prosperity in English agriculture was when the yeoman class was most abundant. Up to the time of Henry VIII. there were a considerable number of small farms; but when the currency was debased, and there was a great desire to get rich by the export of wool, the system of large farming came in. Time had shown, however, that that system had failed. The greatest amount of food could be produced from the land by small farms; that was the result of his own inquiries and of the evidence before the Small Holdin Committee, which also showed that occupyin owners were better off than tenants. He qui agreed that Government assistance was require The Committee recommended that if a man wante to purchase his holding he should pay down on fifth of the purchase money; but that was a gre difficulty, because, as a rule, he would not have suffi cient money to stock his holding and wait until th first year's returns came in. One gentleman wh gave evidence before the Committee recommende that the Government should stock the farm. H would not go so far as that, which he thought woul be absurd; but he did think that where a landlor showed a disposition to adopt this system, every e couragement should be held out to him. Only th day a prominent member of Parliament, a large lan owner in the south, told him that he wished he cou cut up his large farms, but the question of buildin stood in the way, and many others no doubt were the same position. If Government came to the a of such gentlemen, there would be a larger numb of small farms, and he had no doubt the result wou be beneficial. If there were to be small holders, th ought to receive a proper technical education; and the case of labourers this ought to begin even in th elementary schools. The children took very readi to any practical tuition which helped to fit the for their future career, and where there was piece of ground attached to the school, and eac child had a "garden" of his own to look afte if it was only a few feet, they were immense delighted.

The **Chairman**, in proposing a vote of thanks Professor Long, said that some of the criticism passed with regard to decreasing the amount of labo employed while the product was increased had bee slightly inconsistent. In some parts of Normand where *la petite culture* had been developed to a extraordinary extent, one could not help remarkin the enormous number of hands employed compare to the former practice. He had read accounts of th manner in which wheat and other cereals were cult vated in a climate not very different from our ow each seed being sown separately, and the results such cultivation were simply astounding. Wherev that sort of gardening culture was carried out, muc smaller farms than we were accustomed to could made to yield very large results. He did not thin they need fear that education would drive the youn people out of the country. There were other cou tries where compulsory education was carried out to further extent, Switzerland, for instance, and y they never found any difficulty in getting men an women to cultivate the land; and notwithstandin the more rigorous climate, every available corner wa utilised. One of the most interesting parts of th paper was that which referred to the bacteriologic improvement of the soil, which, at very small cos rendered it much more fertile, and he thoug ibly that was one direction in which great nces might be made. He fully endorsed what Green said about technical education, which was mportant in connection with agriculture as with other industry.

he vote of thanks having been passed unani- sly,

rofessor LONG, in reply, said he quite admitted Druce's hypothesis with regard to the economy superintending a large farm rather than a ll one, but in practice it was not so. England a small country, with a large and increasing lation, and it seemed to him that the land must tually become a big garden; and he thought would be in rather the near future. Even to day, en farming was increasing on a large scale; vas called market gardening, but it would tually be the normal mode of farming. Big ing, as a rule, was not intensive or high farm- He did not refer in the paper to small ings in the ordinary sense of the word; he er meant to suggest that a man who had invested v thousands in farming 600 acres might advanta- sly invest the same capital and give the same tion to a farm of 150 or 200 acres. That was d on his own experience, which had taught him he could make more profit by cultivating half area he had some years ago. To farm with ess you must have manure, and farmyard manure the best of all; but you could not obtain this sufficient quantity for a large farm. You l cover the land with sheep if it was suit- ; but the land not sheeped you could not cover with farmyard manure, for hardly anyone as many cattle as they ought, in proportion to and they farmed. Mr. Rew had answered the tion about the buildings, by saying that the rnment should advance the capital. With d to extended ownership, he endorsed the rk made by the Chairman respecting Switzer- which would apply to other countries as He had investigated the small farms of ce, Denmark, Sweden, Switzerland, Holland, Belgium, and could not but be struck by the , the hard work, and the comparative success ved by the small occupier. Of course, these men not aim at the same standard of life as the ish farmer, who mixed with the commercial, , and professional classes, and naturally desired to on a social level with them; they simply farmed livelihood, and were content with plain fare, plain ing, furniture, &c., and he was satisfied that in cases their life was healthier, happier, and more able than that of the more prosperous English r. Mr. Druce suggested that if a man bought olding, he would be compelled to invest capital which he could employ much better in the pur- of stock. His suggestion was just the opposite, that he should be able to buy and till some of this derelict land with Government aid, paying both capital and interest back by annual instalments. With regard to the cost of labour, he recently advertised for two men, the wages in his neighbourhood being 16s. a week and upwards, whilst within a distance of 10 miles they only got 11s.; he found the only objection that men coming from the cheaper districts had to accepting the situation was, that they wanted to be nearer town. He did not suggest that the self-binding reaper should be introduced into England, but he did think that such implements as three-furrowed ploughs and improved drills might be used with advantage. An English drill with three horses and two men and a boy, would cover 8 acres in a day, whilst an American drill would do double that work, with two horses and one man, and would tell you what he had sown, and you could regulate it by simply touching a lever. Some years ago he went to Denmark to see what they were doing in the co-operative butter factories; but he did not think the same system would work well in England, for this simple reason: here there was a good market for milk, which, in London, fetched to-day about 6½d. per gallon. As it took two and a half to three gallons to make a pound of butter, if they attempted to compete with Danish butter they would have to submit to a loss of about 30 per cent. on the market price of milk. With regard to the question of falling prices, he would quote only a few important items. Milk had fallen this year from ½d. to 1d. a gallon; potatoes had fallen from £5 a ton to £1; and he had known large quantities sold by auction at 12s. Butter and cheese had also fallen; and, in spite of any Act to prevent the introduction of live stock from abroad, no doubt the Canadians and others would organise a system of dead meat trade, which would flood the markets and still further reduce the value of meat. With regard to the use of manures, his idea was that mineral manures would be employed for the growth of leguminous plants, and so save expenditure on nitrogenous manures; and if town refuse were utilised, as he hoped it might be, they might be able to do without artificial manures altogether.

Miscellaneous.

THE PROSPECTS OF THE CINCHONA AND QUININE MARKETS.

It is not a little remarkable that one of the most valuable and best-known drugs, namely, quinine, and one of the most valuable and best-known flavouring agents, namely, vanilla, should quite recently have been occupying a considerable amount of commercial attention; the first in consequence of the opening of a new quinine factory in London, and the second in consequence of the extraordinary advance in the price of vanilla, which has been going on for some time. In reference to the first, the *Chemist and Druggist* makes some remarks on the commercial prospects of the company, and on the cinchona-bark produce generally. In the first place, it expresses an opinion that the establishment of a new factory is not likely to have any serious effect upon the market position of the drug, though the entire output of the factory for November was said to have been sold before the month was half through. "The chief point of interest in the situation," it is said, "is that the new factory is the only one in Europe not bound by the 'agreement,' 'convention,' or 'understanding' which has existed for more than a year among the older makers, and has given a healthy tone to the quinine markets." It is further pointed out that the product of the new company is an unknown brand, and that it will take some time to convince the average consumer, especially a British one, who is proverbially loth to leave his time-honoured sources of supply, that the article has all the excellence of the old brands. The possibility of the new makers underselling their rivals is also discussed, and should the older makers declare war upon the new comers, it is considered possible that we may return again to the price-cutting days of 1892, when quinine was purchaseable below 10d. per oz. "The new factory starts at a time when the older manufacturers were believed to be contemplating an all-round advance in their quotations early in the coming year. From the quinine-maker's point of view, the market has been mending for some time, notwithstanding the fact that there has been no improvement worth speaking of in the second-hand quotations, and that the maker's prices have remained unaltered for months. The second-hand stock of quinine in London has been reduced to manageable proportions; the cinchona-bark supply in this country is too small to place any serious impediment in the way of a rise, and at least one of the large German quinine works has been deliberately kept closed all through the summer months. Only the Java producers remain hopelessly disunited. Their exports of cinchona-bark in October reached the enormous total of over 1,200,000 lb. (1,100,000 Amsterdam lb.), and in their present disorganised condition they are almost at the mercy of the quinine makers so far as the price of their produce is concerned. At the present time, the quinine manufacturers pay for the quinine in the bark only about one-fourth of the price at which they quote their finished product, and if only the second-hand stock of quinine were smaller than it is they would not be at all badly off. The facts here stated show to what lengths and variations the traffic in cinchona-bark has extended in the space of time within the memory of many, when the bark was drawn from its native South American forests, and when the manufactured article, quinine, was sold at a guinea an ounce.

General Notes.

◆

Wire Nails.—The manufacture of wire nails
Germany, the principal sorts of which are in the Rhi
Province and Westphalia, as well as at Osnabrück
Hanover, and Gleirvitz in Silesia, has so much i
creased during the last fifteen years, that, aft
having met a gradually growing internal consumptio
it has increased its export by about 250 p
cent. In 1880 the production was only 1,645 ton
and in 1890 it had risen to 41,040 tons, while la
year it attained 56,424 tons. The value of t
exports during these fifteen years amounts to abo
110,000,000 marks (£4,400,000). Nearly half t
exports are taken by Great Britain for 14,300 to
and Japan for 12,500 tons, while the Indian Empi
absorbs 3,730 tons, and Australia 2,770 tons.

MEETINGS FOR THE ENSUING WEE

MONDAY, MARCH 30...Farmers' Club, Salisbury-square Hot
Fleet-street, E.C., 4 p.m. Mr. Hurndall, "T
Management of Dairy Stock."
British Architects, 9, Conduit-street, W., 8 p.
1. William C. Street and Max Clarke, "Bri
work Tests: Report of the First Series of Expe
ments." 2. Matt. Garbutt, "Notes of the B
haviour, while under Compression, of the Fi
Series of Brickwork Piers." 3. Prof. Unwin—
"Notes on the Tests of Bricks;" (ii) "Report
Tests of Lime and Cement used in the Constr
tion of the Experimental Piers at the West In
Docks;" (iii) "Determination of the Loads Cor
sponding to the Gauge Pressures for the La
Hydraulic Press at the West India Docks."
Mr. J. E. Tuit, "Description of the Hydrau
Testing Machine."
Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m
TUESDAY, MARCH 31...Central Chamber of Agriculture
the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.
Dr. E. L. Corthele, "The Tampico Harb
Works."
Anthropological, 3, Hanover-square, W., $8\frac{1}{2}$ p.
Colonial Institute, United Service Instituti
Whitehall, S.W., 8 p.m. Mr. F. A. Swettenha
"British Rule in Malaga."
WEDNESDAY, APRIL 1 ... Photographic Club, Anderto
Hotel, Fleet-street, E.C., 8 p.m. Mr. E. J. W
"The Composition of the Negative Image,
its relation to Speed, Reading, and Print
Qualities."
Archæological Association, 32, Sackville-street,
8 p.m.
Patent Agents, 19, Southampton-buildings, W.
$7\frac{1}{4}$ p.m. 1. Adjourned Diseussion on Mr.
Imray's Paper, "Recent Dicta as to Amendm
of Specifications." 2. Mr. G. de Mestral, "
Application of the Swiss Patent Law and
Execution under the Bureau Federal." 3.
G. Barker, "The Discretionary Powers of
Comptroller."
Obstetrical, 20, Hanover-square, W., 8 p.m.
THURSDAY, APRIL 2...Linnean, Burlington-house, W., 8 p.
1. Mr. C. H. Wright, "Monagraph of the Ge
Stenona, Lour." 2. Messrs. W. and G.
West, "African Algæ."

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

roceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 10, 1896; LEWIS F. DAY the chair.

The paper read was—

ENGLISH BOOK ILLUSTRATION: 1860-70.

By JOSEPH PENNELL.

It may be a matter of wonder if it is thought out at all, why ordinarily rational and sane ists and engravers are beginning to rave er a series of books and magazines, mainly de to soothe the savage child, or while ay the leisure hour. Why should one care works chiefly written for the virtuous arage, printed to comfort the cheerless, ld-grubbing colonial, or published with the e aim of tiding over the somnolent Sunday ernoon? Why should one fill the "Pub- ers' Circular" with wanted advertisements, nt salerooms, disturb the peaceful slumbers he provincial dealer, by unexpected inroads, humble the pride of the Napoleon of Picca- y, by asking for that which he would dis- n to have in his shop at present? Why uld one rush up and down, seeking to annex ed, stained, tattered volumes, the outcasts he nursery and the book-club, bound in a ror of gaudiness, printed upon paper that ses to cleave unto its binding, in type ch it gives one a shudder to look at, en- red within borders that grate upon one, the sharpening of a saw?

ecause these books, the books and maga- s of 1860 to 1870, contain, as illustrations, hat is left of the purest, the most genuine od of English art. The period when artists d their subjects around them—treated them seriously, were not ashamed of being English—or, if they revived, the past added to it the feeling of the present.

Within that ten years all that is most English in art was brought forth, though the result is ignored, many of the men who did the work are unknown, the pictures unseen, and the method by which they were produced despised. For this art is but illustration—which we are told is not art, and it was published as wood engravings—and these are hopelessly confused with wood cuts. Even the authorities mix up the terms in their hurry to expose themselves, that the historian of the future may have more sport than he of to-day.

The most perfect English art that the world has yet seen was done in black and white between the years 1860 and 1870. What an absurdity. Of course, for Blake was absurd, Alfred Stevens ridiculous, Keene ignored, Whistler a joke. And yet, when the amateur tires of his postage stamp and the young lady with no books wearies of her book plate; when all the sham Bartolozzis have been shipped to America, and the Jap print outweighs the bank note, and the cycle is a burden in the land, then possibly the English illustration of 1860 will be discovered, and art in this form will be upon the town.

I use the date 1860, but I ask for as much latitude, as one is granted in speaking of the Romanticists of 1830, with whom the men of 1860 are worthy to be ranked.

Before referring to the books themselves, it may not be out of place to note the causes which led to their publication. Up to 1850 steel and copper plate illustrations were supreme in England for fine books, and imitations of them in wood for cheap ones.

The work of Bewick was forgotten, his methods obsolete, the simplest wash-drawing was turned into an imitation steel-plate by the wood engraver. The artist's lines, even the whole design, was ignored. The engraver was supreme.

No thought was given to Bewick the inventor, nor to Clennell the follower who had done such magnificent *fac-simile* work, after Stothard's pen drawings for Rogers's poems in 1810. Even as early as 1817 the frontispiece to Puckle's Club by John Thomson, is calculated for a while, to deceive the elect, into the belief that it is steel. It has been said lately, on the authority of the author or editor, that this frontispiece is a perfect piece of *fac-simile* engraving—but of what? it is impossible to say whether the drawing on the block was made in line or in wash, with pencil or pen. And unless these elementary facts are stated by the engraver the engraving is not a *fac-simile*—but a travesty of the original.

From that time onwards the imitation of steel (on wood) was aimed at universally. One need but look at Harvey's Dentatus, or when that excellent engraver turned draughtsman, his Solace of Song engraved for him by Orrinsmith, printed and published by Seeley (1837), to be convinced of it. Or at the wonderful work by the Williamses after Cruikshank which is like etching.

Steel and copper died hard, lithography came to their aid, the designs on many of Cruikshank's and Phiz's plates done in metal for them by Winkle and others, were transferred to the lithographic stone and so printed much more cheaply, but they could not be printed with type, and that was the difficulty, and the cause of expense, and the cash-box rules the publisher as well as the author. Even in France wood engraving after its magnificent triumphs in 1830 to 1840 was rather confined to the cheaper publications. Yet in the Magasin Pittoresque, a delightful contrast to Knight's prints, it was coming to the front again, and with Meissonier's Contes Rémois in 1858 established itself anew.

In France, however, they were able to publish books, magazines and papers illustrated by lithography for many years apparently profitably, but then they had a Daumier, a Gavarni, and a Monnier for artists.

Here the best known men—Prout, Nash, Cattermole, Harding, Haigh — all made expensive books, and mostly published them in limited editions.

No matter how little we like to acknowledge it, many of our luxuries and necessities come from Germany, and it is to Germany that one turns for the inspiration of modern illustration, and to Adolph Menzel as its prophet. When, in the late thirties, Menzel was working on his various versions of "Frederick the Great," seeing the results obtained in Curmer's "Paul et Virginie," he confided some of the designs he had drawn upon the wood block to an Anglo-French firm of wood engravers established in Paris, Andrew Best Leloir; but he was not satisfied with the results, which may be seen in the earlier part of Kugler's "Frederick the Great," and so he trained his own engravers, Krutzchmar, Bentworth, Unzelmann, the Vogels, and between them they produced those triumphs of German art which gave the direct inspiratio
to modern illustration. These books are:—

Kugler's "Life of Frederick," 1840.
"The Uniforms of the Army of Frederick,"
1852.
A supplement to the former, by Lange.
"The Works of Frederick," 1850.
"The Heroes of War and Peace," 1856.

These works I have been informed, and I hav
the facts from the artists and engrave
and publishers themselves, if they did not pr
duce a sensation in England, immediately c
their appearance in Germany, (or even on the
re-publication, here, for Kugler's Geschich
Frederichs des Grossen 1840, was issued he
by Bohn in 1845 as "A Pictorial History
Germany,") did have their effect in the follo
ing ten years. The first book which I have see
that shows it is William Allingham's "Tl
Music Master, 1855," and I maintain th
Rossetti in his drawing, that is in his meth
of drawing for engraving, as shown in th
book, must have been inspired by Menzel—f
no book like this had ever been illustrated
England, nor had any similar illustratio
been made previously in this country. Ro
setti, Millais, and Arthur Hughes, who sa
Allingham submitted their genius to the ri
of wood engraving, did the drawings. Rosse
furnished the youth listening in wrapt mo
to the chaunt of the three mystic wom
—"The Maids of Elfin Mere." Burne Jon
then thought it the most beautiful drawing
an illustration he had ever seen. Yet W. I
Rossetti says, "my brother was highly d
satisfied and regarded the wood-cut by Dalzi
(of course it was wood engraving) as a decid
travesty of his work." What would he ha
thought had it been done ten years earlie
Next year, 1856, Samuel Palmer, following t
traditions of Blake, and that lovely decorat
Calvert, illustrated one chapter on the "D
tant Hills, in Adams's "Sacred Allegories
with nine drawings; no such *fac-simile* wo
engravings had been done in England befo
Three or four of these must rank with Turn
He has given the effect of the setting sun ov
great landscape as no one ever did before, a
as no one has attempted since. The engravin
are by T. W. Green, H. Harral, and J.
Measom; the book was printed by Richa
Clay and published by Rivingtons. The
maining illustrations are by Cope, Horsl
and Birket Foster, who has told me his d
pair and disgust at the engravings made
of his drawings previous to this time. Th

is also an edition of Dickens's "Pictures of Italy," by Palmer, but these are unimportant. 1857 is a memorable year, the year of Moxon's Tennyson, which heralds the genius of Millais as an illustrator; it contains the famous Rossetti drawings and Holman Hunt's best design, the Lady of Shallot, but the rest of the illustrations are weak, poor, and commonplace. The engravings, of which one hears little that is good, are by Dalziel and Linton; but it is most interesting to compare the engraving of Sir Galahad from the Rossetti drawing, done by Linton, which is quite characterless so far as the work of Rossetti goes, or rather Lintonesque, save in the small heads, which are very good, with the first drawing in the Palace of Art by Dalziel, also after Rossetti, which is brilliant and ndividual by comparison. Yet Rossetti himself, his brother says, preferred the Linton to the Dalziel. He says, "I have designed five blocks or Tennyson, some of which are still cutting and maiming. It is a thankless task. After a fortnight's work my block goes to the ngraver's, like Agag, delicately, and is hewn o pieces before the Lord Harry.

> "Oh, woodman, spare that block!
> Oh gash not anyhow!
> It took ten days by clock,
> I'd fain preserve it now."

"Chorus of wild laughter from Dalziel's workshop."

It is a pity, as Mr. Soames Layard emarked, that these drawings cannot be ngraved again, to-day, or processed, or made ito steel plates, as Mr. Ruskin suggested; nfortunately they were cut to pieces in the ngraving, a detail which has been rather overoked. Mr. Ruskin backs Rossetti too, in is denunciation of the engravers, but this by self is not of much importance, as in a few ears, just after the very best work had been one, he attacks artists and engravers both, aying, "Cheap popular art cannot draw for ou beauty, sense and honesty, but every pecies of distorted vice, the idiot, the blackuard, the coxcomb, the paltry fool, the disraced woman, are pictured for your honourble pleasure on every page. These are oroughly representative of the entire art dustry of the modern press,"—this is a critism of the men and the books of 1860!

In the same year, 1857, a book, the illusated edition, which is quite unheard of, Willmott's Poets of the 19th Century," was iblished in which an all round standard of eater merit in design and engraving was aintained than in the Tennyson, for to it adox Brown, Dobson, Pickersgill, Tenniel, Harvey, Foster, Arthur Hughes, Harding, Millais, and Gilbert (engraved by Dalziel) contributed—there were fewer academicians, and the men knew better how to draw on wood.

In 1858, John Gilbert, even then the Nestor of English illustration, obtained his chance, and the magnificent Shakespeare, also engraved by Dalziel, was commenced and continued during the two following years; it came out in parts, and is Gilbert's master-piece and still remains the finest complete illustrated edition of Shakespeare. Probably among these books it is the finest example of a book issued in parts or numbers, though the fashion was started by Charles Knight.

If 1857 was notable, 1859 is destined to become historic; for then "Once a Week" appeared, soon to become synonymous with good illustration. The first volume is more an array of names, than a distinguished accomplishment. Millais did eight drawings for it, not one of which can be compared with his designs for the "Tennyson," though he was beginning that series of the costumes and furniture of the period—the crinoline, the chignon, and what not—that artists now find so interesting and the public so droll. Harvey did one, and there are a number by Phiz, Leech, Hine, Tenniel, and many crude things signed Keene, which are commonplace. They were all engraved by Swain, or as Keene himself puts it, they fell before the graver of Swain. After this, Keene appears continuously, always more and more interesting; but, save for his "Caudle Lectures," he is scarcely a book illustrator; yet his fame is secure, his position as an illustrator acknowledged.

I have said already that it is to these magazines that we must turn for all that is left of English illustration of the sixties; for this reason all the final finished drawings were made on the wood block, and consequently destroyed in the process, and, save those wood blocks, most of which have vanished, and possibly some engravers' proofs and the prints in the magazines and books themselves, there is absolutely nothing else left. Therefore the world, which always wants what it cannot have, may understand how important are these early volumes, when it knows anything of them at all.

1860 marks the start of the "Cornhill" and "Good Words," both issued because of the success of "Once a Week." As the "Cornhill" was a monthly, there was more time to prepare and print the illustrations, which are on separate, unbacked sheets, while the "Once a Week" blocks are printed in the text.

To the first number of the "Cornhill," Thackeray, more or less worked over by ghosts and engravers, contributed the illustrations for "Lovel the Widower." But, in the second or third number, Millais was called in, and then G A. Sala, to complete the work. Frederick Sandys illustrated the "Legend of the Portent;" this is, so far as I know, his first appearance as a book illustrator; the lithographed burlesque of St. Isumbras is earlier. And the volume ends with Millais' splendid design "Was it not a lie?" for "Framley Parsonage." From this time onward, Millais gives character and distinction to its pages—the grace of the crinoline, the beauty of the frock coat and the top-hat, the daintiness of the pantalette, are shown in every number, while the fine æsthetic houses are full of interest. It is curious to note that either Thackeray or the publisher omits to mention the names of the artists in any way, Millais and Sala alone sign their designs with their monograms. Sir Frederick Leighton, I imagine, contributed the "Great God Pan," signed L., to the second volume, while his drawings for "Romola" are among the later attractions; and Dicky Doyle began his "Bird's Eye Views of Society" in the third, but it is not until one is more than half way through this volume that the initials, F.W., appear on what are supposed to be Thackeray's drawings; or, rather, it is not until then that the great author acknowledged his failure as an illustrator. There is one of his "Roundabout Papers" which shows how, eventually, he admitted his indebtedness to Walker with the best grace in the world. The first drawing signed by Walker, a fact interesting enough to be recorded, faces page 556, 1861; the "Nurse and Doctor." This illustrates Thackeray's "Philip." Mr. Comyns Carr says, Walker's first drawing was published in "Everybody's Journal," illustrating a tale by Edmond About, "The Round of Wrong," (1, 14, 1860); and his first in "Once a Week," is (2, 18, 1860) illustrating an article "Peasant Proprietorship," signed H.E.

"Good Words" also was started in 1860, and Mr. Strahan published in the first numbers drawings by the then young Scotchmen, Orchardson, Pettie, Graham, and MacWhirter. *Punch* was then brilliant and distinguished, and this was due to DuMaurier and Keene. For some reason most of the men seem to have continued to do work for "Once a Week," whether they had contracts to dra for it, or whether they liked working for or firm better than another I do not know, b for the first few years "Once a Week" is t most interesting.

I do not know of any notable books in 186 save "Quarles's Emblems" by C. H. Bennet which I believe was once very popular, but 1862 Miss Rossetti's poems, illustrated by h brother with two drawings, came out. designed the cover; the illustrations as illustr tions can hardly be called satisfactory, as in on Lizzie is a frightened country girl, in the oth a stately Rossetti woman; the volume n contains two more which were added in 188 William Sharp says William Morris engrav the frontispiece to this book signed W. M. and Co. Mr. S. C. Cockerell tells me it w engraved by another member of the firm, Faulkner.

Despite the better printing of "T Cornhill" in the beginning, in the ea number of "Good Words" a most nota series of illustrations by Millais "The Pa bles of our Lord" were printed in 1862 as well as work by Whistler, Holman Hu Keene and Walker, A. Boyd Hought Frederick Sandys, Pinwell, North, Armste and many others who now began to come the front in this magazine and in "Once Week." Indeed there must have been m good illustrated magazines issued in 1865 England than there are to-day in the wh world. Not only were the three I h mentioned continued, but "The Argos "London Society," "The Sunday Magazin and "The Shilling Magazine," and " Quiver," among others, printed fine work all these artists.

The illustrations were done in a curious very interesting way. The entire work bega be undertaken by two firms, Messrs. Dalz and Swain; I believe in the case of "G Words" the same system is still follow or was till lately, by Mr. Edward Whymp These firms commissioned the drawings fr the artists and then engraved them, method seems to have been so successful t engravers, notably the Dalziels, not only e ployed artists to make drawings and t engraved the blocks themselves, but beca their own printers as well. It was in t manner they produced the books which bound to become the admiration and desp of the intelligent and artistic collector. W the books were printed they were sold t publisher, who merely put his imprint hem; but to this day they are known as Dalziel's illustrated editions, that is when hey are known at all. The first important ook of the series which I have seen is Birket Foster's "Pictures of English Landscape," 1863, Routledge; printed by Dalziel, 'Pictures in Words by Tom Taylor," this however, had been preceded by a horrid inted affair and by the same artist, called 'Odes and Sonnets." The binding is trocious; the paper is spotting and losing olour, but the drawings must have been exuisite, and here and there the ink is spreading nd giving a lovely tone, like an etching, to he prints on the pages. This autumn Mr. Nimmo revived it as "Pictures of Rustic Landcape," with literary selections by John Davidon. Of course, there is no mention of the ct that the engravings appeared thirty-three ears ago. In the same year F. Shields did a hilling edition of Defoe's "Plague," with six rawings engraved by Swain and Morton. It ust be one of the earliest of illustrated shil- ng volumes; it contains Mr. Shields's best esigns. The "dead pit," into which, by e flaring light of torches, the bodies are ing shot from the cart, is like Rembrandt in power. And there is some good work by mstead, Holman Hunt, and Sandys in illmott's "English Sacred Poetry."

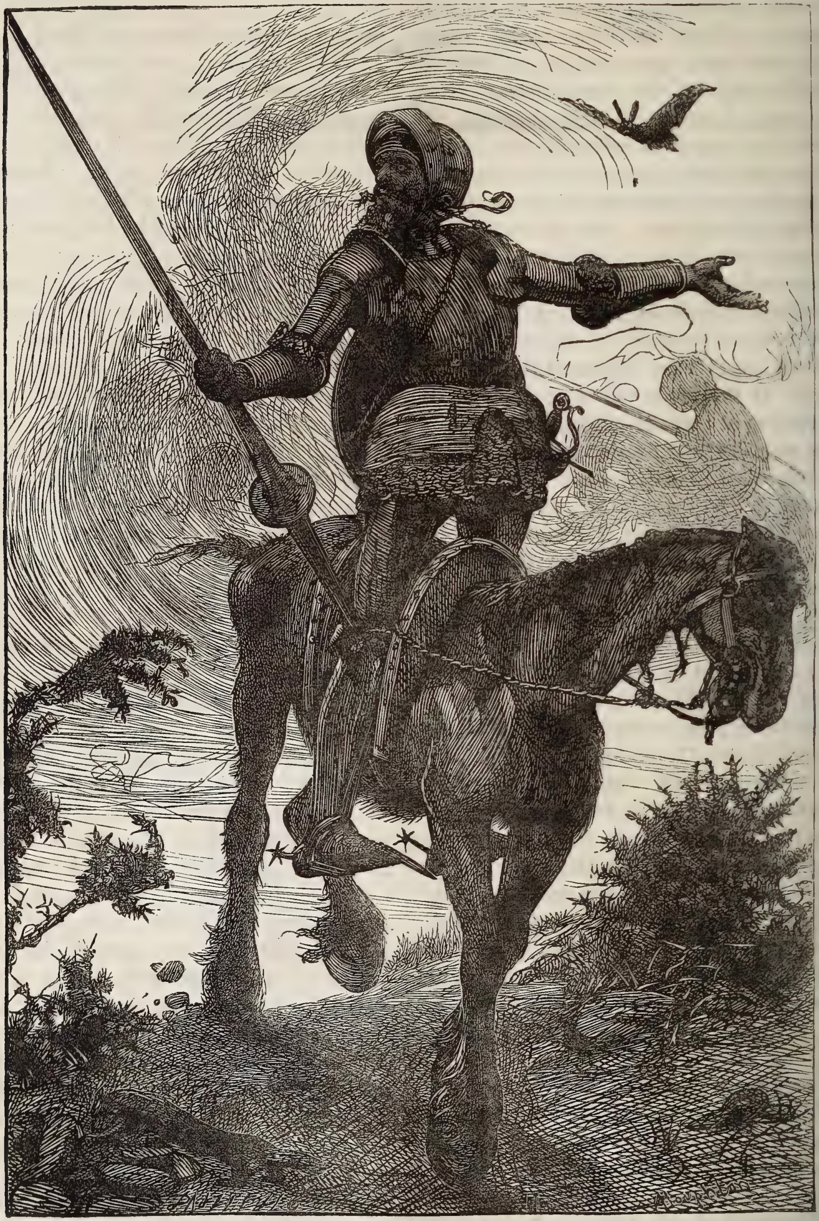
In 1864, Messrs. Dalziel, who had already the previous year engraved the designs "Good Words," published in a volume illais' "Parables of our Lord," through outledge. This book, in an atrocious bindg, described as elaborate—as it truly is—und up so badly that it has broken all to eces, printed with some text in red and black, ntains much of the strongest work Sir J. E. llais ever did. Nothing could exceed in amatic power, or in effect of light, "The emy sowing Tares" or "The Lost Piece of ver;" in beauty of line or realistic treatnt of the foreground, "The Sower," to ntion only three blocks where so many are so od. The whole book is excellent, and is now cessively rare in its first edition. In this ar W. J. Linton illustrated, drawing and graving the designs for Mrs. Lynn Linton's Lake Country" (Smith, Elder & Co.) It is a ious book, and exemplifies Mr. Linton's thods, of which I may say I had rather he graved his own designs than mine.

But 1865 is the most notable year of all. To belongs Dalziel's Illustrated "Arabian ghts' Entertainment," originally published parts, I believe, and later in two volumes, with text and pictures enclosed in horrid borders (Ward and Lock). In this edition of the "Arabian Nights" A. Boyd Houghton first showed what a really great man he was. He clearly proved himself the English master of technique as well as of imagination, although he had as fellow illustrators, Sir J. E. Millais, J. D. Watson, Sir John Tenniel, G. J. Pinwell, and Thomas Dalziel. Houghton, however, towers above them all, and Mr. Lawrence Housman, in an able article on him in "Bibliographica," vol. i., well says: "Among artists and those who care at all deeply for the great things of art, he cannot be forgotten; for them his work is at once too much an influence and a problem, and though officially the Academy shuts its mouth at him while it opens it wide to applaud the more popular art of Walker and Pinwell certain of its leading lights have been heard unofficially to declare he was the greatest of the three." Again he writes, "technically, his work, always in line with a brush or pencil, is most simple and powerful, the value of 'whites' asserted almost by the yard: broad white upon black, black upon broad white; yet there are searching draughtsmanship marvels of subtle modelling, and always that strange touch of realism that would give rags their squalor, and limbs the hairiness of life."

In 1865, also, his "Home Thoughts and Home Scenes" was published (Routledge). It is much less imaginative than his later work, but contains, perhaps, more that is beautiful: studies of child life, beautifully seen, beautifully drawn. After this, he worked prodigiously, and yet excellently. His edition of "Don Quixote" (Warne), as a whole rather overrated, yet good in parts, must be sought for now in the most out-of-the-way places; still it is very Spanish in character, and this is all the more wonderful, if, as I have heard, he never was in Spain or in the East. Easier to find are his "Kriloff's Fables," 1869 (Strahan). Best known of all are his drawings in the early numbers of the "Graphic," the American series, which were not all published, I think, before he died. If some of these are grotesque, almost even to caricature, they are amazingly powerful, and being his largest engraved works left, show him fortunately at his best. His original drawings scarce exist at all. They were nearly all done on the wood, and though at times he did several versions of each he destroyed all save the one that pleased him. I happen to have one of the most beautiful "Tom, Tom, the Piper's Son," from Novello's "Nursery

Rhymes," 1871, drawn on paper. There are others at South Kensington and the British Museum on wood, and Mr. Fairfax Murray has another; two more were lately shown at the Fine Arts Society; while I have lat heard that his sister has several.

I have not pretended to give a list Houghton's drawings; to do so would be but impossible; but the books and magazines I have mentioned contain the most important.



FRONTISPIECE TO "DON QUIXOTE." BY A. B. HOUGHTON.*

Another distinguished event of 1865 was the publication by Ward and Lock of the edition of "Goldsmith," in which G. J. Pinwell r vealed his marvellous powers, but his most in portant work is of a later date.

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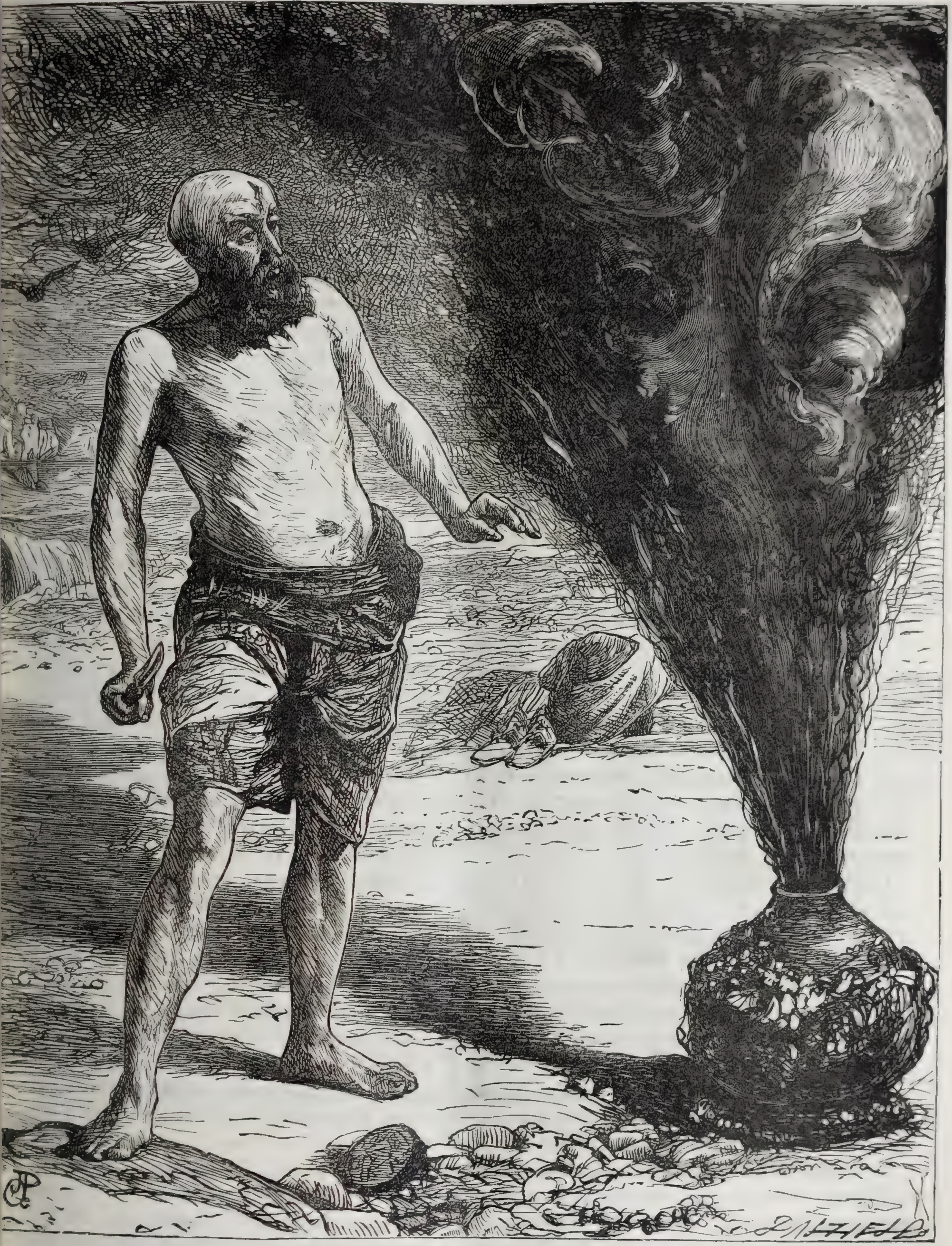
* This illustration has been kindly lent by Mess Frederick Warne & Co.

Cassells issued many works by Doré about the same period, and in the same year appeared "Gulliver" by T. Morten, among others, though this volume is not dated. Griset's "Grotesques" and "Æsop's Fables" are also about this date. The uniform edition of Dickens was



THE FISHERMAN AND THE GENIE. BY G. J. PINWELL.*

oming out, illustrated by C. Green, Luke ildes, Marcus Stone, J. Mahoney, and F. arnard. F. Sandys is, in imaginative power, the greatest of all these illustrators, in technique he is the legitimate successor of Dürer, in popularity he is a failure. He has never illustrated a book; so far as I know he made but few drawings specially for books, these are in Wilmott's "Sacred Poetry," 1863, "Life's Journey," "The Little Mourner," and in Dalziel's Bible.

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* This illustration has been kindly lent by Messrs. Ward, Lock, Bowden and Co.

In 1861, a number of his drawings were printed in "Once a Week." "Yet once more let the organ play," Ægina, and others, In everyone is seen the hand of the man able to carry on the tradition of Dürer, and yet bring it into line with modern methods. So far as I am aware, Ruskin never mentions him; how much this was owing to the famous Sir Isumbras caricature, "The Nightmare," I do not know. All the spirit of early German art breathes through his drawings. But it is during the next year, 1862, that Sandys, becoming accustomed to the wood block, did some of his most powerful work. "The Old Chartist," "King Warwulf," "Harold," "Once a Week." In this Old Chartist there is the real Dürer feeling in the distant landscape, but the trees are better than Dürer's trees and the figure is one that Sandys has seen for himself. But in all his work there is this evidence of things seen and studied. Mr. Fairfax Murray and Mr. Ashby Sterry possess some most elaborate studies for these drawings—many were in the possession of Mr. Anderson Rose and dispersed at his sale. 1862 was his most productive year; in 1863 there are but four drawings and none in 1864; in 1865 a magnificent "Amor Mundi" for Miss Rossetti's poem printed in the April number of the "Shilling Magazine."

There are only one or two after that and then he disappears. I found the Danae block in Swain's office, and it was published first in the "Hobby Horse" in 1888, and I have an original on the wood, never engraved, which appeared or rather a process block of it in the "London Garland," published by Macmillan for the Society of Illustrators.

There are many drawings by him on paper, but it is safe to say no man with so few drawings on wood ever made such a reputation.

True, Mr. Whistler only made four in "Once a Week" (1861-2), but he was known as an etcher and painter at the time. Whistler did a catalogue of Blue and White for Ellis and Elvey in 1878, illustrated by autotypes, but this was only issued in a very limited edition. One day it will rank far above Jacquemart's books.

In 1865 the illustrated books began to contain the best illustrations, attracting the better
men, by the greater care with which they we
printed, the larger size of the page: st
DuMaurier, Lawless, Holiday, Millais, Smal
and Keene contributed regularly to th
magazines.

Expensive gift books by Houghton, Pinwe
North, and Walker were now commence
perfectly new drawings being used for the
illustration. In 1866 "A Round of Days
was issued by Routledge; Walker, Nort
Pinwell, and E. Dalziel came off best in th
gorgeous morocco-covered volume, especial
Dalziel, who contributes a striking Noctur
"The beauty of night," discovered by Whistl
being appreciated by these illustrators, ev
while Ruskin was busy reviling or ignori
them. Houghton's edition of "Don Quixote
(F. Warne and Co.) is another of the books
1866. How illustrators then could accompli
so much masterly work in such a short time I
not know or understand. In 1867 "Waysi
Posies" and "Jean Ingelow's Poems" we
published by Routledge and Longmans. The
two books reach the high water-mark
English illustration. In them North a
Pinwell surpass themselves, the one in lan
scape, the other in figures; and Dalziel
quite amazing in studies of mist and rain a
night, which, I imagine, were at the ti
absolutely unnoticed by the critics. T
drawings of the school, however, must ha
been popular, for Smith and Elder reprint
the Walkers from the "Cornhill," in
"Gallery;" and Strahan reprinted "Touch
of Nature" (1867), and also collected in
portfolio the Millais drawings (1866), printe
it is said, from the original blocks. The fi
"Cornhill Gallery" came out in 1864, possi
as an atonement for the shabby way in whi
the artists had been treated in the magazin

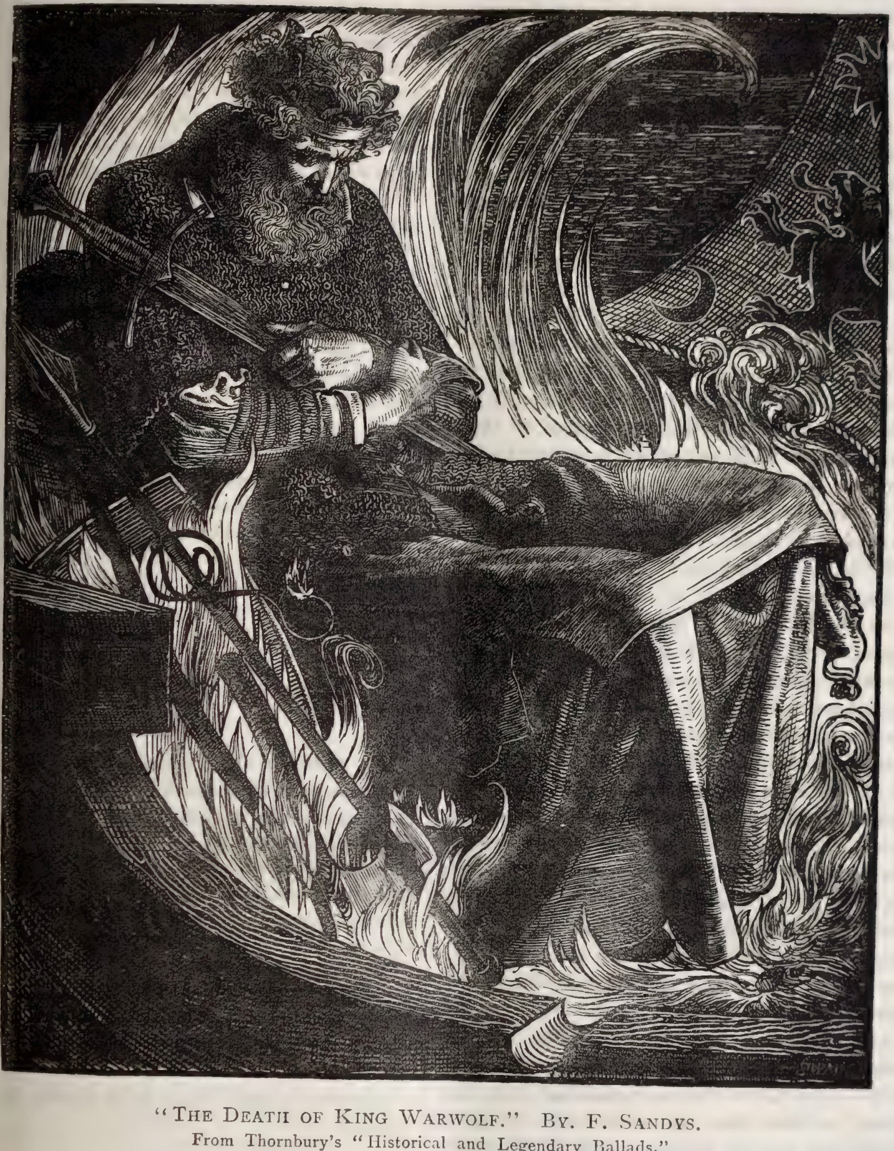
In 1868 "The North Coast," by Buchan
was issued by Routledge; much good work
Houghton is hidden away in its pages. T
next year the "Graphic" was started, a
these books virtually ceased to appear. Th
were some spasmodic efforts to produce n
ones, most notable of which were Tennie
"Alice in Wonderland" and "Through t
Looking-glass." Harrison Weir's ani
studies, Whymper's magnificent "Scrambl
Amongst the Alps," containing J. Mahone
best drawings and Whymper's best engra
ings, and Thornbury's "Historical a
Legendary Ballads" (Chatto and Wind
1876), made up from the early numbers of
magazines, and boasting special distinct
because of the rare Whistler and San

rawings which are included. It is almost the nly book in which one can find the work of ese two men, although their drawings were ot done originally for it, as the editor would ke one to believe.

In 1877 the "Graphic" published a portfolio ade up from their early numbers.

In 1878 "Nature Pictures," drawn by J. H. Dell and engraved by Patterson, was issued. As an example of what *fac-simile* wood engravings is capable of, it is amazing, the most elaborate pen work being wonderfully *fac-similed* in wood.

Dalziels issued at least two books later on; gnificent India proofs of "English Rustic tures," printed from the original blocks by well and Walker, done for the books I have ntioned—"Wayside Posies" and "A Round Days." This volume is undated; and ir "Bible Gallery" (1881) the drawings having been made long before and kept back till they could be photographed on wood. Many of the drawings, which but a few years ago they vainly tried to sell, are now among the treasures of South Kensington. All the best-known artists contributed to the "Bible



"The Death of King Warwolf." By. F. Sandys.
From Thornbury's "Historical and Legendary Ballads."

Gallery," yet the result was not altogether a success. The most conspicuously good drawings are by Ford Madox Brown, Leighton, Burne Jones, Sandys, Poynter, Houghton, and Dalziel. It is the last great English book illustrated by a band of artists and engravers working together. Whether the results are satisfactory or not, the fact remains that the engravers were most enthusiastic and encouraged the artists as no one has done since, in the making of books, and the artists were the most distinguished draughtsmen who have ever appeared in England. In the early numbers of the "Graphic" there are many marvellous drawings by these men, and by Green, Woods, Linton, Fildes, Macbeth, Gregory, Herkomer. In not a few cases the most distinguished work of some of the present R.A.'s is in the "Graphic."

I am perfectly aware that this is by no means a complete list of the books of what I have called the 1860 period. It is but an attempt to describe the great value and importance of the illustrations many of them contain. But, until yesterday, modern illustration was but a necessary evil, illustrators a bore, now they are an ever-present, ever-advertised nuisance.

But many of the books I have mentioned are as important as those of the 15th century so far as the pictures go, yet no record has been kept of them, they are mostly unknown, and the chief object of this paper is to point the importance of cataloguing, classifying, rescuing, and preserving the books which contain them. You may say this has been done. But say you want to find a certain Millais, a particular Sandys, or a striking Houghton which you remember vaguely to have seen in some book somewhere. I think I should be quite safe often in giving you a week to do so, in the British Museum. The catalogues in libraries are useless, even the British Museum does not possess—at least I can't find them—all the books I have mentioned. Shopkeepers are insulted if you ask for them. Old booksellers know nothing of them, though they are now taking pains to learn, and they are learning fast. But among artists there is a rapidly-growing admiration for the pictures, and in ten years the books will be rightly considered treasure houses of English art.

DISCUSSION.

The CHAIRMAN said Mr. Pennell had given them a very interesting and amusing paper. The illustrations he had shown must have called back to ma pleasant memories of days when they were you To others they must have given a much better ide the art of thirty years ago than could be got fr back numbers of periodicals or old gift books. Pennell had spoken out, and said pretty much what thought, as he always did; and had provided am food for discussion.

Mr. ABLETT said he had recently heard it sta by Sir James Linton at a dinner of the Society Illustrators that Sir John Gilbert drew directly u wood—that he would go to an entertainment ceremony and come back, and, without any p-liminary drawings, make the sketch straight a upon wood. He should like to ask whether many of illustrators of that day drew from memory or im-nation, or whether Sir John Gilbert was the one. He had also heard that Sir John Tenniel d without the direct aid of models.

Mr. PENNELL said he could not answer the qu-tion. No doubt some people did use models, t whether Sir John Gilbert did or did not he s unable to say.

Mr. THOMSON thought they must all be very m h obliged to Mr. Pennell for his interesting paper s it broke entirely new ground. There were m y young artists living who sighed for recognition in e way pointed out by Mr. Pennell. This was the st public sign that they had had of the recognitio of artists between the years 1860 and 1870. He e-membered as a boy quite well the publicatio of "Gulliver's Travels" and the "Arabian Nigh" the pictures in which struck him as being won r-fully clever.

Mr. TIMOTHY COLE said there was one rema in the paper which had struck him, viz., that engr rs cut the picture to pieces, and an instance had en given that evening. He would suggest the vo pictures should be again thrown on the screen, nd that Mr. Pennell should point out exactly wh it was he referred to.

Mr. LAWRENCE HOUSMAN said he was inter ed in cutting blocks, and as Mr. Dalziel had lent m the picture of "Tom, Tom, the Piper's Son, he intended to compare it with the wood engraving

The two pictures being again thrown upon he screen,

Mr. PENNELL said it would be seen tha he original was drawn on paper which was w ed over a great deal with Chinese white, and he dress was all drawn in with Indian ink as a se, and was worked over with pencil. In the ori al the lines were beautiful, but in the engraving a he grey tint had been omitted. One could see at re was a simplification, though whether it was for better or worse he could not say. In the engrav- the face had lost enormously. In the drawing face was most exquisite. The back-ground had been absolutely changed, and again, the bird completely changed in character, and the same ght be said as to the trees, and the gate post. ıether the engraver had to simplify it because he ld not print it he was unable to say. In the wing by Sandys, it was quite another thing; there lines were closely followed. In many of his wings the lines were absolutely followed, but it st not be forgotten that he drew with a pen. ıdys had stated that some of his pictures were ly engraved, while with others he was perfectly sfied.

Ir. **Timothy Cole** said it must not be forgotten this was a photograph on the wood, and the tograph was not so effective then as in the ient day. The drawings were probably the same as the photograph on the wood would be.

[r. **Pennell** said no doubt they would be very ly the same.

r. **Cole** said that would increase the difficulty ıendously. For his own part he thought the aver had done admirably well.

r. **Crockett** said he had known Mr. Pennell for y years, and although he seldom agreed with him, ad the pleasure of being in accord with him this ing. He knew nothing about art except which Pennell had been pleased to tell him. Some s ago Mr. Pennell had been good enough to tell somewhat of what he told the audience that t about these wonderful books, and, as a result, Mr. Crockett) had collected most of the books. elt it a great pleasure and honour to have spent ırst night in London this year in listening to the r, which he had enjoyed immensely.

r. **George Clulow** thought that the preparation e paper must have involved an immense amount search. On a previous occasion he had remarked the omission of certain engravers, and the one h occurred to his mind most was that of Edmund ıs, who did some of the best wood engraving of the d eferred to by Mr. Pennell. The majority of the drawings on wood by Birket Foster were engraved vans. He had recently had occasion to go over , and was much struck by the wonderful intelli- shown in Evans's work, which was done by wn hands at that time, and not, as in later years, hers, under his signature,

e **Chairman** said it struck him while Mr. ell was talking as being curious that, at the time ıs referring to, photography was only just coming he field, but now they were coming to a period when photography was expected to do the whole of the work. That was a very great change in the course of a comparatively short time. Allusion had been made to the attempts of the early wood engraving, to imitate the delicacy of the copper plate, which it supplanted. It was notable that the newest wood engraving (the American) was also endeavouring—though in its own way—to reach a delicacy which one had been more accustomed to associate with steel or copper. Contrary to Mr. Pennell, he thought that Chas. Keene's illustrations to Chas. Reade's "Good Fight," in "Once a Week," was quite worthy of him, indeed, admirable. There was a certain flavour of the mediocre manner about them, in keeping with the story; but the manner was still the artist's own. Reference had been made to "Quarles's Emblems," by Chas. Bennett, but no reference had been made to Harry Rogers, who was responsible for what was best in the book, Rogers was the one man of the period who did put something like art into the ornamental work of that date. When the title page, or cover of a book, happened by exception to be ornamented with grace and distinction, it was sure to be the work of Harry Rogers. He had looked up so much to Rogers, when he was young, that he did not like to see his name left out. In conclusion, he proposed a hearty vote of thanks to Mr. Pennell.

Mr. **Pennell** said the reason he had not referred to Edmund Evans was because the engravings which he made after Foster were all done before the period with which the paper dealt. His great work was in colour, and his re-productions of Caldecott and Crane were perfectly amazing. He ought to have mentioned the name of J. D. Cooper, who engraved some of Caldecott's books. To his mind photography had nothing to do with the matter. It was not till 1865 when "Wayside Poesies" came out that photography was made much use of. As to the "Good Fight" he thought that the Chairman's memory was somewhat at fault. There where some very commonplace things there, and it was not until one got half way through the story that Keene began to show himself. In the first year he was rather tied down—he seemed to be afraid to let himself go. It had been said that Thackeray did not think it worth while to give the names of the artists, but in "Good Words" and "Once a Week" the artists were given great prominence, while in "Cornhill" they were never acknowledged. It had been said that he had omitted to mention the name of Harry Rogers; he would again look up Rogers's works and try to see the great beauty that Mr. Day found in them.

The vote of thanks was unanimously carried, and the meeting adjourned.

Mr. **John Leighton**, F.S.A., writes:—I greatly regret my inability to be present at the meeting to hear

Mr. Pennell read his paper upon "Illustration, temp. 1860-70," these being the departing days of hand printing and xylography which have now given way to chemical engraving, and steam printing, books being now produced at one-fourth of the price demanded twenty years since. Having been one of the illustrators of "Once a Week," and the possessor of an entire proof copy of that periodical, I could have spoken of that work, and of how Keene told me that he was influenced by Menzel, and how Caldecott was influenced by Rowlandson, whilst Meissonnier, the precursor of Keene, produced cuts that really might be taken for Keene's. When a great man is a precursor, it comes hard upon his successor. This may be seen by contrasting Bewick's with Yarrell's works, the former being roughly printed, without "overlays," while that of the latter is perfection. Bewick came out of black and dexterous broken lining, Yarrell's—or rather Vasey and Bentley (engraver and printer)—out of white, clean cutting, and clear impression. I will refrain from dealing with process and rapid reproduction, noting the names of Clay, Clarke of Edinburgh, and Bradbury, as the hand printers of the period. Previous to 1860 I employed all the great wood engravers upon my version of the "Moral Emblems." That went through three editions, being followed by the "Lyra Germanica," in which I was aided by Edwd. Armitage, F. M. Browne, C. Keene, M. Lawless, H. S. Marks, and in which I produced the first photographs upon wood in the form of two bas-reliefs from Flaxman, they being engraved, in perpendicular tint, by Thomas Bolton. These hymns, though Lutheran and highly Protestant, were illustrated by me, with all the Roman Catholic symbols, a fact that attracted no hostile notice, but seemed to enhance their wide popularity, though once such treatment would have been fatal.

Miscellaneous.

EXHIBITION OF MOTORS.

An International Exhibition of Motors and their appliances, and a Congress of Motor Industries, will be held at the Imperial Institute during the months of May, June, July, and August, in the North Gallery and South-east Quadrangle. The arrangement is as follows:—Section 1, motor pleasure carriages propelled by—(1) steam, (2) oil, (3) electricity, (4) compressed air, (5) springs. Section 2, self-propelled vehicles employed on roads for trade purposes and for transport of goods. Section 3, self-propelled ploughs and other agricultural implements. Section 4, self-propelled cycles. Section 5, wheels, tyres, axles, springs, seats, cushions, and the various parts used in the construction of the above three classes or of the machinery connected therewith. Section 6, apparatus for aerial navigation, through the agency of motors. Section 7, examples of carriages and vehicles not self-propell . Section 8, cycles not self-propelled, which emb y some novel principle of construction. Section , road maps, hotel and railway guides, and books f views for the use of tourists. Section 10, knapsac , portmanteaus, cooking appliances, tents, picnic b kets, and other tourists' conveniences. Section , launches, boats, and yachts propelled by (1) ste , (2) oil, (3) electricity, (4) compressed air. Sect n 12, lamps and approach signals, as applied o carriages and other road vehicles, and to launch , yachts, and boats. Section 13, watches, cloc , compasses, pedometers, and other travellers' rec sites. Section 14, stationary engines, dynamos, d motors. Section 15, models of inventions, worki , and otherwise, in connection with the foregoing.

THE PREPARATION OF OPIUM I ISPAHAN.

The preparation of opium is by no means a s ll or unimportant industry in Ispahan. Almost e y native or European merchant who trades in this d g sees the opium prepared under his own eye. er Majesty's Consul at Ispahan gives the follow g description of the process:—The people comme e to collect the drug early in May. The poppy hea is lanced in the afternoon, and the opium which ex s and dries during the night is collected into cop r pots early the following morning. The op n gathered is kept in store until it is required to e prepared, in thick earthenware or copper pots, d special men are engaged who understand the m ipulation of crude opium. The first operation i o take the opium out of the pots and sort it. It is then placed in a very large copper pot. n the manipulation each workman has a sm h board about twenty-three inches long and ele n inches broad. He takes from the bulk about e pound of the crude opium and rubs it on the bo d, puts it in the sun for about ten minutes, and a rwards takes it into the shade and rubs it c tinuously on the same board with an iron implem t having a wooden handle, something like a s ll solid spade, and continues in the same manner u l it dries up, to a certain degree. It is then colle d together in a mass sufficient for about a day's w k, and then heated over a small charcoal fire in t s until it becomes plastic; each man then takes a t a quarter of a pound and keeps kneading it on e board and manipulating it with the implemen s already described until it dries up to the stand d degree and assumes a somewhat golden col r. The opium is then collected, and made up o cakes of one lb. each. These cakes, after a co e of days ,are wrapped up in pink paper, and d round with string, then put into tin boxes, pac d in layers with poppy chaff, so that the cakes do t roll about, and then packed into wooden bo s. The boxes are covered with hide and gunny, and e ium is then ready for exportation. If the drug is epared in cold weather, it has first of all to be dried artificial warmth, and by rubbing on the board d keeping the boards while in manipulation near a arcoal fire.

Correspondence.

HE MIGRATIONS OF THE TOBACCO PLANT, THE FARNESIAN CASSIA, AND THE LOMBARDY POPLAR.

I would solicit a brief space to record in the *Journal the Society of Arts* some criticisms I have received ›m a scientist of the highest authority, in correction statements made by me in the course of my remarks Mr. Tripp's recent paper on "The Tobacco dustry of India and the Far East."

I. My correspondent writes:—"It is by no means rtain that the Old World owes the Farnesian cacia to the New. It appears to be indigenous to ustralia, and not impossibly to Asia."

I was aware that the *Acacia Farnesiana* had been entified by Fraas with the "white Acacia" of ıeophrastus, and the "Acacia in Cappadocia," &c., Dioscorides; but I know of no solid ground for is identification; while, on the other hand, it is scribed as a native Chilian plant by Molina, in e 16th century, from which date it is gradually ıced through a succession of writers eastward, in aly, the Morea and Greek Islands, in the gardens Egypt and Arabia, and in Western India. From ıenos Ayres, it was carried by Europeans into ›uisiana, and as far north as Charleston, d again by Europeans it was carried from merica westward to Tahiti and the Philippines, Timor and Java, and apparently to Burmah d the Coromandel coast of India. It has w overspread all India. Everywhere its name ems to be derived from its exquisite "aroma," and the Greek writers do not refer to this, its overıelming characteristic, I accepted it as a plant of clusively American origin, and one of the most lightful gifts of the old world to the new. It is st botanically described by Hyacinthus Ambrosinus D. 1605-72.

2. My correspondent writes:—"The 'Lombardy ›plar' is only a fastigiate variety of our *Populus gra*, and is certainly not American." And again: "The 'Lombardy Poplar' is European, but the 3lack Italian' is American."

I am not entitled to gainsay this dictum, but I asoned thus. The Greeks and Romans knew only e three following poplars:—

Populus alba, Linn.: the *ἀχερωίς* [*i.e.*, "of cheron"] of Iliad xiii. 389 and xvi. 482, the ύκη of Theophratus and others, and the "populus ba" of Pliny xvi. 35 (23);

P. nigra, Linn.: the *αἴγειρος* of Iliad iv. 482, Odyssey ix. 141 and x. 510, and of Theophrastus, and Hippocrates, and the "populus nigra" of Pliny, in *loco cit.*

P. tremula, Linn.: the *αἴγειρος μακεδνός* of Odyssey vii. 106, and "populus Lybica" of Pliny in *loco cit.*

These three (*P. canesceres* being regarded as a variety of *P. alba*, and *P. græca* of *P. tremula*) would seem to be the only poplars truly indigenous to Europe; the rest being nearly all American species. But to-day there is to be seen everywhere throughout Europe the pyramidal "Lombardy Poplar," *Populus fastigiata*, said to be a variety, but if so, a powerfully differentiated variety of *P. nigra*. Some regard it as a native of Central Asia, others of North America, *i.e.*, of Carolina, and the valley of the Mississippi. It is the *P. italica-carolonensis* of Brugsdorf; and inasmuch as it was not introduced into Lombardy, between Milan and Pavia, before the 17th century, nor into France and Great Britain before the 18th century, I concluded that it came into Europe rather from the Mississippi than from Persia. Had this "Kenspeckle" poplar been a native of Anterior Asia it seems to me that Homer would certainly have known of it, and given it a discriminating epithet, *πυραμιδικός*, or the like.

3. My correspondent writes:—"There are only two tobaccos used, the pink-flowered *Nicotiana Tabacum*, and the yellow *N. rustica*. I doubt if the latter is much grown, except in the Levant, for cigarettes. I do not believe it furnishes Brazilian, Germany and Hungarian tobacco. You perpetuate a very old error about Persian or Shirzaz tobacco. *N. persica* is not a variety, but a species. It is the same as *N. alata*, and white flowered. It does not yield tobacco. The blunder is due to Lindley; and Shirzaz tobacco is only the ordinary *N. Tabacum*."

I relied on Lindley and Pereira, but on referring to the "Kew Bulletin," No. 52, for April, 1891, for for having overlooked which until to-day I am most blameworthy, I find that Mr. Thiselton Dyer has there conclusively demonstrated my critic's contention on this point. I erred through writing "in a castle (of Indolence)—cock-sure."

GEORGE BIRDWOOD.

25th March, 1896.

PURE COFFEE.

The paper that was lately read at the Chamber of Commerce on the subject of agriculture took a view of how oppressed this department is by rates and taxes. The medical profession decided that if milk could be obtained in a pure form it was extremely valuable as a food, and, further, that its consumption would be very largely increased. All this has taken place, and even now the analytical chemist is continually on the watch to attack either the farmer for sending milk of too poor a quality to market, or else the retailer because his milk is not up to the standard.

Lately, at the Annual Meeting of the Chemical

Trade Section of the Chamber of Commerce, I put it to some of the analytical chemists who belong to our branch whether they were not now pretty well satisfied with the quality of the milk; they admitted they were. I then asked them another question, viz., were they not aware that, at the present time, if they went into almost any hotel, restaurant, coffee-house, and many private houses, they could not obtain pure coffee, and that at many railway stations the beverage called "coffee" was nothing but an adulterated mixture? They admitted this to be the case, but said they had not been instructed by the Government to proceed against this vile system of the adulteration of coffee.

I took the opportunity of explaining to the Committee that the adulteration consisted of beans, bad dried fruit ground up, and as a fact the very best and richest coffees yielding the best flavours were all sold at a high price to people who used them, because they would flavour the largest amount of adulterating matter.

After the deputation waited upon the Chancellor of the Exchequer, at the end of February, to appeal against the duty on coffee, I wrote to the Chancellor of the Exchequer telling him that I entirely agreed with some of the members of the deputation, that the reason of the falling off in revenue from coffee was attributable to the filthy adulterating matter that was employed when people required and purchased ground coffee.

I am glad to say that the Chancellor of the Exchequer took the same view that I did upon the matter, and agreed with some of the members of the deputation that waited upon him; and it was pointed out that the department responsible for allowing this adulteration, and, in fact, robbery of the Excise, is conducted by Sir Michael Hicks Beach. If these facts are admitted, we may conclude that the poor English farmer, who has delivered to the hotel or restaurant pure milk, has been most unfairly treated by the Government authorities, for he has been forced to abide by most stringent conditions; and now he finds that the vendor of "coffee," so called, may sell any admixture in a shop, and other vendors may sell any adulterated article under the name of "coffee" direct to the public.

The coffee dealers in Mincing-lane, who have an immense stake in this business, subscribed together and formed a committee, and they gave pure coffee to certain people as long as they would agree to sell it to anyone who asked for a cup of coffee at their establishment, and there are very few establishments left now where the sale of this pure coffee has been continued.

Would it not be fairer to trade in general if the Government administered justice in this branch? because I maintain that, now we have such excellent quality of milk, good coffee would be greatly appreciated, and very soon coffee drinkers would be able to discriminate between the different sorts of coffees that were supplied to them.

While discussing this question from an English point of view, I should like to further remark that in France, now, it is most difficult to get a cup of pure coffee; so much so is this the case, that if you ask at a good restaurant for a cup of their best coffee after breakfast or after dinner, they charge you an extra price for it.

In Germany the so-called "coffee" which is supplied contains really less of the pure berry than it does in either England or France, and immense quantities of figs and dates are sold to adulterate the coffee—in fact, I am informed that the adulterating material is present in a larger proportion than the pure coffee. Yet in both France and Germany it is most important that the trade of their colonies should be fostered. In conclusion I would like to remark that so many peopl ask for coffee, and if they only had pure coffee give to them, the demand for genuine coffee would be s great that it would cause a rise in the market price and at once tend to improve the revenues of ou dependencies.

THOS. CHRISTY.

31st March, 1896.

SECONDARY SCHOOLS IN DENMARK.

Mr. J. S. THORNTON writes:—I have latel received from the Minister of Education i Denmark, through Mr. Folkethingsmand H. Hol six or seven copies of the latest Blue-book o secondary schools (*i.e.*, Latin schools and *Realskole* in Denmark, as well as two sets of the offici publication by Weis and Hage on the regulatio that govern secondary education there. A copy the former work, by Asmussen, will be sent to th Society of Arts. Though the educational cond tions of Denmark resemble our own much mo closely than those of any other country whateve they are yet so little known in this country, a still present such startling features to the averag English legislator, that it would be premature attempt to forecast what precise influence Danis performance in the field of secondary education m exercise on the plans we are busily formulating England. But it is, at any rate, useful to see first hand what those performances really are.

General Notes.

GLASGOW PHOTOGRAPHIC EXHIBITION. — T Corporation of Glasgow will inaugurate the N Camphill Gallery with a Photographic Exhibiti which will be held from the early part of June to t end of September. The Exhibition will comprise: (1) Illustrations of the History of Photography; (Photographic Instruments, Materials and Applianc Lenses, Cameras, Chemicals, &c.; (3) Illustratio of Processes in Photography; (4) Applications Photography.

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATION IN MUSIC.

The Practical Examinations in Vocal and nstrumental Music will be conducted by Ir. John Farmer, Balliol College, Oxford, nd Director of the Harrow Music School, xaminer, and Mr. Ernest Walker, M.A., Mus.Bac. Oxon, and Mr. Burnham Horner organ), Assistant Examiners, at the House f the Society, and will commence on Ionday, 22nd June.

Particulars can be obtained on application o the Secretary.

roceedings of the Society.

OREIGN & COLONIAL SECTION.

Tuesday evening, March 24, 1896; Sir Vestby B. Perceval, K.C.M.G., in the hair.

The Chairman having briefly introduced Mr. alentine, and spoken to his qualifications for ealing with the subject,

Sir Charles Kennedy, K.C.M.G., C.B., said he Society of Arts had always taken a very eep interest in whatever tended to promote the rade interests of the empire, and especially the rade between the United Kingdom and her olonies, and between the Colonies themselves. o question could be more important at the resent time than that of our food supply, and they ere fortunate in having such a valuable contribution o the subject as the present paper. He regretted hat a longstanding engagement prevented his emaining to hear it read and discussed. The ociety, and especially the Foreign and Colonial ection, were much aided by the Agents-General f the different colonies, who attended the meetings f the committee and gave valuable advice and assistance with regard to the papers. In this connection no one had rendered more continuous and valuable aid than Sir Westby Perceval, and they were very fortunate in having him in the chair that evening.

The paper read was—

THE COLONIES AND THE SUPPLY OF DAIRY PRODUCE AND PRODUCTS OF PETITE CULTURE.

By Charles R. Valentine.

The extent to which England is dependent upon over-sea supplies of food is enormous and increasing. The magnitude of these supplies is no new tale to lay before a British audience, but it is only right to say that this dependency upon the foreign and colonial supplies of food has not been altogether brought about by what I may term the unadaptableness of the British farmer to the times, or the rooted conservatism of his practice, so much as by some of the conditions under which he farms. Indeed, we may take it that while population has increased, home production has done little or nothing during the last 15 years towards feeding the new mouths, and, in the meantime, the 34,500,000 consumers of 1880 have become the 40,000,000 of 1896. There is a further cause for this enormous trade in foodstuffs—I am speaking to-day of other produce than meat. There has been, we must all agree happily, a distinct rise in the standard of living of those who use their hands—the toilers forming the bulk of our population. This is a constant factor, increasing demand per head. Further, by reason of their geographical position, our Colonies, especially our Australasian colonies, are able to supply such things as dairy produce, poultry, fruit, rabbits, &c., when the glut season of the English producer has passed. But further than this, the gradual development of agriculture in the Colonies, the return as it were of the colonist from the cities to the land after the bursting of financial bubbles that have led to such places as Melbourne being almost deserted, in comparison with past few years, has turned the colonial attention to producing foods of the nature I have named, for the home market. The Colonial Governments, as will be seen, have lent their aid in this object, with much success, and directed the efforts of the producers in various ways to which I shall allude. Generally, it will suffice to point out that the Colonial Governments have taken care to find out what the English consumers want, how and when they want it, and the best methods of producing and sending it. What the producers now do not know of the English trade is very little. This policy has led to the colonial producers recognising the fact that their advantage is to produce of the best, and to send only carefully graded goods of best quality. A good name means riches, and experience is teaching that the fall in price of inferior produce is relatively greater in years of abundance than the fall in price of the best qualities. Hence many of the products of, say, New Zealand, are now recognised by their name as "first rate," and if in the neighbouring continent of Australia the idea that England may be exploited as a dumping ground for any kind of produce still obtains to some extent, the hard lessons of experience coupled with the paternal legislation and instruction of their governments is changing all that, and the Colonies can produce, and are producing, dairy produce and other "luxuries" equal to a high average quality of the home country's, and at a profit, for a lower price than their competitors making the same qualities. In dairying the co-operative factory system has been a great benefit, and in its train are following the other occupations of the agriculturist.

The United States are gradually becoming the consumers of their own vast produce, and the time is not perhaps very very far off, when our colony of Canada may find her better market in the Republic, at least for her less bulky produce. I shall, briefly as I can, endeavour to show the production of our Colonies, their export, and their capabilities. Rather than deduce many arguments from the facts I lay before you, I shall merely place them as concisely as I can, with the obvious conclusions from them.

At the outset I shall premise that the Colonies can vie with, and, indeed, excel, any European country in producing most of the articles I refer to, and have the further advantage, in the matter of dairy produce and fruit and poultry, in being able to supply fresh grass butter, summer fruits, and spring chickens, when the north temperate zone is in the depth of winter. The colonist has cheap land, and the advantages of the climatic conditions referred to. He has to contend with dear labour and freights, and, until more recently, has had to make a name and secure a more sympathetic means of distribution. If, now, we balance the land advantage against the labour disadvantage, and take climatic advantages, virgin soil, and Government help to go towards balancing the freight difficulty, we are left with the balance of freight against the colonial producer and the difficulties of distribution. To meet this difficulty of freights is now the only question: the co-operative factory and the cold-storage system, with the aid of the sympathetic operations of several leading firms here, are doing a good deal to secure that regularity in bulk and time which is necessary to any transit system; but this regulating of supplies and consignments is anything but general. It affects the vital interests of the Australasian colonies. Canada we may consider to be at our doors, for the fluctuations in the markets here are felt there at once, so much so, that North American produce has crossed the Atlantic back again here, for sale when a sudden rise in prices has taken place.

To meet, then, the handicap of freights, it is necessary that all the export trade from Australasia should be thoroughly organised, with a view to regulating shipments, and ensuring their uniformity in bulk and sequence of delivery. And now we are led here to note a disadvantage that now exists as a tax upon the Australasian producers. Owing to irregularity of shipments, it is a fact to-day that the existing cold storage capacity of the vessels that actually sail is little more than half availed of. Based at per sheep carcase it may be said that where vessels made six journeys, four would have done.

With regard to distribution here there is room for improvement; the produce should not be gambled with, and the consignments might be sent direct to the large consuming centres. The idea is still too largely prevalent in the Australasian Colonies that London is England, as far as the market is concerned, and it is not recognised what vast aggregations of population exist around Birmingham and south Staffordshire, the Lancashire cotton towns and the potteries of north Staffordshire, the north of England mining and iron districts, and west and south Yorkshire. All these have natural centres for distribution, and have consuming populations, any two or three at least, as numerous as working London, and composed of well-paid earners whose standard of living makes them a vast field for the consumption of colonial products.

Having dealt with the matter of freight in the manner I suggest, and having secured a more sympathetic means of distribution which will not merely farm the colonists' exports, and dea and gamble with them, but trade them to the best advantage of the producers and share those advantages, I have no doubt that in most of the articles I mention the Colonies could feed the old country to advantage and cheaply, apart from continental supplies. I will say nothing of the patriotic sentiment that should induce many of us at least to prefer the produce of the Queen's dominions, made with English hands by English methods across the sea, to that of any foreign country. Sentiment, of course, has little weight in trade, and the colonists are recognising that intrinsic merit will alone carry the day. With the general modifications I have named, the development of the industries I deal with is assured. I will first take

BUTTER.

Imports into United Kingdom.

	1892. Cwt.	1893. Cwt.	1894. Cwt.	1895. Cwt.
Total Import ...	2,183,009	2,327,474	2,574,835	2,825,682
Value..............		£12,753,598	£13,456,699	£14,245,230

Without going back into remote history, it will suffice to point out that the total imports here in 1889—six years ago—were under 2,000,000 cwt., so that the consumption of imported butter has increased by nearly 1,000,000 cwt. in six years. Of this vast supply the producers have been as follow:—

	1892.	1893.	1894.	1895.
Canada	59,571	43.160	20,887	38,949
Australasia	87,520	169,439	292,097	313,398
United States	46,846	22,930	29,996	66,932
Sweden	228,885	267,401	266,306	310,809
Denmark	863,532	934,787	1,102,493	1,162,770
Germany	124,233	164,985	137,755	112,338
Holland..............	141,838	142,811	165,157	191,221
France	542,687	468,317	424,645	454,843
Other countries ...	87,897	113,644	135,999	174,422

A glance at the figures tells us this, that three countries are mainly responsible for the million hundredweights extra. Canada sent less by 20,000 cwt. than in 1892; the United States export is less than in 1889 or 1890, and very variable; German butter is coming in less quantities; and France has sent less in 1895, by 110,000 cwt., than she did in 1889—so much for the loss of repute. The development has been in Danish, Swedish, Dutch, and Australasian exports. In none of the former has the ratio progress been anything like what it has been in the last-named. In four years Australasia has increased her export of butter from 87,520 cwt. to 313,398 cwt.—nearly four times. Sweden has added upwards of one-third to her export, which approaches the Australasian figures; and Denmark, whose struggle with the Colonies is *à outrance*—for she lives by her dairy produce and its concomitant bacon — has added nearly 300,000 cwt. to her output—nearly as much as Australasia and Sweden send altogether, and is responsible for two-fifths of the whole import. In her case, this rate of progression cannot go on, and when the next total increase of 1,000,000 cwt. comes to be recorded, Australasia will have claimed an even larger share than since 1892, prior to which she only figured in "other countries" in the ordinary Board of Trade Returns. In 1895, Australasia almost exactly supplied one-ninth of the butter imported here. Colonial dairy produce has now a firm foothold, and Australasia is looked to largely as the supplier of dairy produce in winter. In the matter of production and shipment, the Colonies are adopting modern appliances and the most approved methods of manufacture, and devoting careful attention to the means of transit. Although prices rule low, yet with the advantages we have alluded to, and the reduced freights which must follow ever-increasing shipping competition, in the matter of the supply of dairy produce, the pre-eminence of Australasia is assured, as an example of the survival of the fittest.

In the production of specially choice cheese and butter Britain cannot but hold her own, and to this end must the home producer labour. In the supply of the bulk of what is known in the trade as "ordinary finest," or fine quality cheese or butter, the home producer cannot possibly compete with the colonial. It is for Great Britain to supply herself with milk, and reduce the immense consumption of the not too wholesome condensed milk, leaving her Colonies to be the suppliers in bulk of butter and cheese.

Canada.—Canada's supply of butter towards British needs is equal to about one-eighth of that of the Australasian Colonies, or 39,000 cwt. A considerable proportion of this butter is now factory or creamery-made, though up to 1890 the bulk was home-made butter, the total butter production of the colony being then 116,000,000 lbs., or about a million hundredweights. There are some 200 creameries now in Canadian territory, the bulk of which are in the provinces of Quebec and Ontario. The growth of the dairying industry has been wonderful, but more marked in cheese than in butter, for whilst ten years (1881 to 1891) saw the total output of butter increase from 104,252,000 lbs. to 115,938,000 lbs. — due largely to the increased factory make in the province of Quebec—the total output of cheese increased from 63,901,000 lbs. in 1881, to 114,981,000 lbs. in 1891, of which the factory-made cheese comprised 108,714,000 lbs. Creameries in Quebec increased fivefold in the decade referred to, whilst cheese factories in Canada at this date must number nearly 2,000, as there were 1,565 in 1891. Seventy-five per cent. of the cows of Canada, of which there are some 2,000,000, are in the provinces of Ontario and Quebec. In 1891, there were in Canada one cow to 2·6 of the population, it being about one to three in Denmark in 1891. Here in Britain it may be noted that the proportion of cows to persons has gradually declined, and whereas in 1871-75 there were 82 cows per 1,000 people, the returns for 1894 showed that there were only 72. In fact, while consumption of dairy produce is increasing, the British producers appear to be doing less to meet it.

There are now signs of some recovery in Canada's output and export of butter, which are less than they were before the confederation of the colony. Canada, it should be mentioned, is naturally looking to secure a market in the British West Indies, who take some 700,000 lbs. of "foreign and colonial" butter from the United Kingdom yearly. In 1893, Canada, despite her comparative proximity, only sent 40,000 lbs., and there would appear to be an opening here for a regularly-conducted trade. Canada, however, naturally looks to the English market for her butter disposal; for though she sends the United States a little, the States are still an exporting country. Canada is learning from Danish methods how to build up and extend a butter trade with the United Kingdom by the same means which have been so successful in the case of cheese. In dairying she is in possession of no great climatic advantages, but has the great advantage of very cheap food-stuffs for stock. There is an unlimited granary at hand, and the possibilities of the extension of the dairying industry in Manitoba are also very great. In Manitoba, in 1895, the average yield of grain was put at 28 bushels per acre, and attention is now being paid to dairying. Food and water supply are at hand, and already there are 61 cheese and butter factories in tha province.

The effects of proper dairy produce in th matter of the butter trade will now be manifes in the Canadian export. In 1890 a Dairy Commissioner was appointed to act in conjunctio with the Experimental Farm. Agricultural methods now are falling into a regular groove and attention being paid to every branch o farming. The importance of winning a goo name for Canadian butter is recognised now and every facility is being provided to place i fresh, sweet, and good on the English market Cold storage service on the railways an steamships for the shipment of butter to Grea Britain in summer is provided, and cold storage is being more generally used now f storing the butter immediately it is made Attention is being turned to the growth o Indian corn for fodder for winter dairying Winter dairying stations have been fitted u for buttermaking, and in the province o Ontario a good deal of winter butter is mad at factories. It affords a useful direct revenu and the number and quality of the cows kep can be increased and improved, whilst swin rearing is carried on in conjunction with i Assistant Dairy Commissioners and travellin dairy schools have spread knowledge throug the chief provinces; Manitoba and the north west territories are, as we have seen, givin more attention to dairy farming, and soon th valleys of British Columbia, which are admi ably adapted to dairy farming, will be helpin to send their quota of butter to the old countr

It should be added that to encourage th development of the butter trade the Canadia Government undertook to guarantee a retur equal to 10d. per lb. on butter to the shipp last year. As this price was several pence pe lb. above the quotations in London a larg sum must have been paid as an indirect bonu to make up the deficiency. The bonus syste does not stimulate a genuine trader, and ther are few circumstances under which it is of immediate advantage. It, however, spreads th knowledge of how to make up supplies for th market.

AUSTRALASIA.

We have stated that in 1895 Australasi sent one-ninth of the butter imported int England. At an outside estimate, the tot consumption in Britain is 5,000,000 cw of butter, of which three-fifths is importe and two-fifths home-made. Two things a obvious. That the home country and Canad uld largely increase their summer output if e English farmer had more combination and ade energy, and was less hampered by ilway rates and high rents; and if the anadian butter industry increases with any- ing like the vigour of the cheese trade simi- rly organised, we could see England and anada supplying the bulk of the summer emand. The second point is that Austra- sia with her unrivalled facilities and advan- ges for the manufacture of fresh grass butter winter might step in and fill the winter gap. ur dairy bill would not feel so obnoxious if e were paying it to our own folks across the ea. The Colonies of course must aim at the op of the market, and are doing so. Let us riefly see what Australasia does in the way f butter production.

In 1885, New South Wales sent 393 cwt. of utter to England, and New Zealand sent ,028 cwt. Two years later South Australia ad joined in with 59 cwt., and Victoria with 21 cwt., which had multiplied her small export o this country sevenfold, and New Zealand had ncreased her export three and a-half times. et the total Australasian contribution not ten ears ago did not amount to one two-hundredth f the butter imported by Great Britain. By 890 New Zealand had multiplied her 1887 xport of butter seven times to 24,318 cwt.; New South Wales threefold, to 7,003 cwt.; whilst Victoria's 421 cwt. of 1887 became ,708 cwt. in 1890, and South Australasia's xport was something like New South Wales's n 1885. The Australasian export, in 1890, hus represented one-forty-eighth of the foreign mport into England. But a more startling development was to come. Victoria, by leaps nd bounds, advanced her export of butter ntil, in 1894, she alone sent England 190,398 wt.; New Zealand made steady progress to 5,600 cwt.; New South Wales, similarly, to 4,500 cwt.; and South Australian exports had egun to be noticeable as about 1,500 cwt. In 894, the total Australasian butter imported by Great Britain amounted to about one-eighth of he whole amount imported.

A totally new era may be said to have begun n Australasian farming during the past few years, and nothing indicates it better than the figures we have just quoted. The change has been brought about by the necessity of making a living out of the land, and the turning of the populations back from the cities to the country. The financial crisis has had this effect. The change in Australasian agriculture is, in fact, one from mere "occupancy" to "farming." Meat raising has in its wake dairying, and the latter encourages the accompaniments of bacon and poultry rearing. It is not many years since the squatters, and, indeed, the whole population depended largely upon exports from the United Kingdom for their supply of butter. High prices were then paid for even this, but still higher were the prices for fresh butter near the diggings. Old colonists can recall the time when the settler would ride to the diggings with a basket of 10 lb. or 15 lb. of butter, which would make 2s. 6d. to 3s. per lb. In Australasia the new system of dairying was practically inaugurated by New Zealand, and early attention was paid to improved methods in New South Wales and Victoria.

New Zealand.—(Export of butter, 1894, 65,626 cwt.) = between one-fifth and one-fourth of the whole Australian export.

Despite all New Zealand has done, it is in the infancy of its productiveness, for of every 1,000 acres of its area, only 22 have been brought under cultivation; and its cultivated area under crops is 1,250,000 acres, or little more than the total acreage under crops of the West Riding of Yorkshire. About 14 years ago, the New Zealand Government gave £500 for the first 50 tons of cheese exported made on the factory or co-operative system, and hence started the co-operative factory system of the colony that now is such an important and necessary feature in its development.

Prior to the factory system, the production was sold to storekeepers in exchange for goods supplied. The butter so obtained was then "blended" almost indiscriminately with various classes of butter similarly obtained, and shipped to Australia to a great extent, and afterwards to this country. This method of slumping the butter away soon became impossible, and the factory system was adopted. The Government have done everything in the way of providing advice, teaching, and encouragement; they have legislated strictly, to ensure, as far as possible, the conditions that are necessary to the production of the best; and they have provided stringent regulations, to prevent any butter of an inferior nature leaving the shores of New Zealand for Great Britain. These efforts to secure a good name, and to keep it, have been very successful; they may be costly, but they are absolutely necessary if it is hoped to secure a remunerative trade in England. The lesson of last year's low prices has been well driven home by now in every colony—not merely New Zealand—that cheapness affects the lower qualities more than the higher, and that reputable products have a steady market. The efforts of the New Zealand Department of Agriculture have had a most satisfactory result. The factory system is spreading, and there are now some 200 factories in the colony. These are run either on co-operative lines, where the contributors of milk are shareholders, or are erected by companies or individuals. In both cases milk is bought by quality, and it is estimated that the factories and creameries in operation annually produce 8,167,500 lbs. of cheese and 6,722,303 lbs. of butter. The work at the factories is assisted by the working of the Dairy Industry Act, which makes many things that are necessary to the production of good butter compulsory. The Act provides for the cleanliness of the byres, and gives inspectors extensive powers to prevent the supply of milk from diseased cows or unclean premises. It also provides for the aëration of the milk immediately it is drawn from the cow; factories are to be registered, and their produce marked with a stencil and registered number provided by the Government. It also deals with the matter of grading and storing of produce in the cool-store prior to shipment, and its provisions are most useful. The bulk of New Zealand butter comes to hand here in November to March, the imports into Great Britain of New Zealand butter from June to October being little more than nominal. The hold that New Zealand butter has on the market is due to the improved management of the factories. An export trade in bulk must be carried on on uniform lines. Only by the factory system can a large quantity of uniformly finest butter be turned out, and it is this uniformity of good quality that will alone make the industry profitable. The best home dairy may here and there beat the best factory, but a mixture of dairies, never can.

It would seem that purely pastoral farming in New Zealand will be greatly modified, and the farming of the future points to mixed husbandry—the growing of grain, beef, wool, and mutton, combined with the production of milk, pork, and fruit. There is still an immense area of land that can be put under dairying and enormously increase the output, and no country is capable of producing richer or better milk, or producing it more cheaply than New Zealand.

Victoria.—(Export, 1895, 212,624 cwt., or two-thirds of Australasian export that year). This colony, whose rapid march to the front as an exporter of dairy produce has been generally touched upon, leads the way in Ant podian agriculture in many respects. I 3,019,000 acres under cultivation represent per cent. out of every 1,000 or over 5¼ per cen of its total area, a proportion largely in exce of any other colony. The proportion in Gre Britain is 57 per cent., so that we may ga for this some idea of the possibilities of t future of this and the other Australian colonie Tasmania having 32 acres out of every 1,0 cultivated; New Zealand, 22; South Australi 5; New South Wales, 8; and Queenslar only three-fifth and Westralia only one-fifth an acre per 1,000. The colony is self-suppor ing in breadstuffs, about half the cultivat area being under wheat, the other produc including all those of the farm, as well olives, opium poppies, tobacco, vines, mu berry trees, oranges and lemons, &c.

In 1894, the colony had 431,962 milch cow whose annual yield, estimated at the cor paratively low figure of 290 gallons per yea came to 125,268,980 gallons. Of this, tw thirds, nearly, was made into butter, near one-third consumed in its natural state, ar 4,250,000 gallons made into cheese. T Government have used every effort to devel their export trade with Great Britain by givi bonuses, encouraging the co-operative facto and creamery system (so that farmers the selves should have little more to do than lo after their farms and send their milk to central depot), the starting of travelli classes for dairies, providing Government le turers, and promoting agricultural educati generally. As a bonus for dairy produ and fruits of best quality exported a su of £79,000 was appropriated, besides oth grants. The result of this policy is spoken as an unqualified success, and though t payment of bonuses for butter factories an creameries is discontinued, a large increase numbers has taken place. No bonuses on t export of butter were paid after 1893, yet in 189 190,398 cwt. were exported to Great Britai as against 105,994 cwt. in 1893. A very we arranged system of butter export is adopte The butter is sent down from the factories Melbourne in cool cars. There it is placed in th Government depot and inspected. The gradin system, however, is hardly as perfectly carrie out as it might be, but the average of eac shipment is supposed to be up to the qualit which the Government deem to be sufficientl high to bear their stamp. Those makes that d not come up to this have to be shipped at th owners' cost, and do not bear the Govern nt stamp. The Government practically ntrols the export of the produce by taking the available space on the steamers, and recent contract entered into by them with o shipping companies allows ¾d. per lb. net the carriage of butter. The result of all is is that the exports of dairy produce, bbits, game, honey, eggs, and the produce petite culture from Victoria, amounted in lue in 1894-5 to £1,119,076, or a little over per head of the population of the colony. ere were in Victoria in 1893-94 133 butter d cheese factories, of which 111 were ex- isively for butter, 17 for cheese, and 5 for th products. The potentialities of Victoria a supplier of first class butter in the winter onths here will then be seen to be very eat indeed.

New South Wales.—Imports of New South ales butter to the United Kingdom in 1895 is 45,827 cwt., a little less than one-eighth Australasian butter imported here. The port of butter from New South Wales to this untry 10 years ago was virtually *nil.* But e development of the frozen meat industry is brought cold storage and refrigerating ambers to the front, and with this has rried with it all opportunity and trading in itter, cheese, fruit, game, and poultry, and l articles that need the help of the refrigerator their transit to Europe. Through the frozen utton trade in the first instance it became orth while to provide this accommodation, d this is interesting as showing how one dustry, largely practised, induces others. *n passant,* I may point out in this con- ction that our colonies for this same reason e threatened by a new competitor whose iirying development would seem to be treading the footsteps of her meat trade. I refer to rgentina where butter and cheese are being ade, and a recent statement in the *Buenos yres Standard,* quoted in the *Journal* of e Board of Agriculture was to the effect that port of butter on a very large scale was only a estion of time. In the first six months to ne, 1895, 138 cwt. of butter from Argentina ere imported into the Unired Kingdom, and om then until the end of February, 1896, ,000 cwt.

Wheat, hay, and maize are the chief crops f New South Wales, but it does not produce fficient for its wants. All the more im- ortant to such a colony, there is a good ex- ort trade in farm produce, it can produce heaply and well. Meat, butter, cheese, and ine, fruit and tobacco, are some of the staple exports to look to, and here again Government lend a willing hand to the dairy. The butter trade is a new, young growth, but it is being developed on the same lines as in New Zealand, whose example New South Wales has cordially followed. Formerly, the colony both imported and exported butter, because only in spring and early summer was the home produce sufficient. Importation has now, however, practically ceased, and, in 1893, the large surplus of 2,705,000 lbs. of butter was available for export. The favourable reception of New South Wales butter in London has given a stimulus to the dairy industry.

Difficulties in the way of the development of the trade two years ago were the bad condition in which some of the milk was delivered at the factories through carelessness on the part of the producers, the factory managers relied too much upon the capabilities of the machine, and not on their own care, and the industry was also handicapped by the want of a better system of cool cars on the railways, and cold storage while awaiting shipment. These drawbacks the Government have turned their attention to on the lines of New Zealand policy. In the handling of butter prior to shipment, much was deficient a year or less ago; but there has been a considerable improvement since; so that, with the colony's capacity to carry much more stock, the gradual change from the pastoral to the real farming industry, New South Wales's dairying development must advance as rapidly and as markedly in the near future as in the near past. Uniformity is now obtained by the establishment of central butter factories, fed by separating establishments, called creameries. The mildness of the winter season, the suitableness of the grasses for dairy farming make milk production easy and profitable; and the yield of milk per cow compares favourably with what it is here. Yearly, New South Wales butter will take a better footing on the market, and displace much inferior Continental.

South Australia, butter export into United Kingdom, 1,351 cwt. in 1895, and *West Australia, Queensland,* and *Tasmania, nil.*—These colonies have little or no dairy produce available for exportation. The first three are the vastest colonies of the island continent, South Australia being three times as large as New South Wales, Westralia even larger, New South Wales being nearly four times the area of Victoria. Queensland is tropical and the rainfall high; the south of South Australia is like New South Wales and Victoria, which it adjoins; West Australia has a mean temperature of 64° in the south, but more north the heat is excessive. Tasmania has an extremely genial climatic temperature, and with no great variation, and the island is a health resort. Freezing chambers have been constructed at Adelaide, South Australia, to deal with meat, poultry, fruit, &c.; and a bonus of £15,000, in 1892, was devoted to encourage a butter export. This reached 1,825 cwt. in 1893, and 1,492 cwt. in 1894. The bonus was given mainly to teach the colonists how to make, prepare, pack, and consign butter, and has not had time to bear fruit. The total produce of butter in the colony was 4,621,000 lbs., and of cheese 1,442,000 lbs., in 1892. The production of butter is much the same in Queensland in quantity, but that colony imports a good bulk of cheese. In Queensland dairy instruction has been given by travelling dairies and factories established so that an export trade is looked forward to. The export of Tasmanian butter has occupied the attention of the Tasmanian Council of Agriculture. A little trade has been done, but it appears that an extra freightage, amounting to 5 per cent., is charged upon Tasmanian butter by steamship companies, which makes the export more difficult. Terms, however, have been arranged with Melbourne shipping firms, and doubtless a regular butter export will be established.

In considering the dairy production of these Colonies, their capacity for carrying stock must be taken into account. Victoria, the best stocked, has 1·6 acres to every sheep; New South Wales, 2·4 acres to every sheep; Tasmania, 4·6 acres to every sheep; and New Zealand, 2·3 acres to every sheep. Taking all the circumstances of the Colonies into consideration, Mr. T. A. Coghlan, the Government statistician of New South Wales, is of opinion that Australasia could carry 126,000,000 more sheep, or their equivalent, 12,000,000 more cattle. With extensive agriculture on the best lands, even more might be done. Inquiry into the trade in Australasian butter leads to the conclusion that the supply can be made unlimited; that the production is cheap; and the quality easily maintained at a high level, so that the trade can be kept up at a profit in the face of any competition. Further than this, there is a point in Australian makes of butter that, weight for weight, make them of more value to the consumer than many of the foreign and Irish butters imported. This is the fact that both in Australia and New Zealand the water is worked out with a vie of improving the keeping quality, and man of the finest colonial brands show only from o 12 per cent. of water, as against an aver e of 16 per cent. of Danish and anything up o 28 per cent. of Irish. It is just as well t at purchasers should know how much water t y are buying, and in Australian butter they e receiving as little as it is possible to mak it up with.

CHEESE.

England imports annually considerably o er 2,000,000 cwt. of cheese (and "fille" cheese!), Canada, the United States, d Holland being the largest contributors in e order named. Then France, New Zeala l, Belgium.

In 1895 the total import was 2,133,809 c ., of which Canada sent 1,150,018 cwt., or m e than half; the United States, 500,409 cwt.- r less than one-fourth; Holland, 305,290 cwt – or about one-seventh; and Australasia, 92, 9 cwt., or one twenty-third. Canada's prop - tion shows despite bad prices a slight increa , and prior to 1892 was considerably less th n half, her increase apparently having been t the expense of the United States and Holla . In 1893, Australia's share of the British sup y was about one-sixtieth, and in 1894 about o - forty-second part.

The Australasian Colonies exporting che e to England are New Zealand, 75,430 cwt. n 1895; New South Wales, 6,268 cwt. in 18 ; and Victoria, 11,597 cwt. in 1895. Prior o that and the previous year the export of e last two was virtually nothing. Ten years a o the same may be said of New Zealand.

Canada draws from the old coun y £2,500,000 sterling a year for cheese—it w s less last year slightly owing to the glut f produce caused by the plentifulness of grass n Europe. What the industry means then to c huge American colony, half of whose pop - lation rely for their sustenance on agricultu , can be realised. The direction of the man - facture of dairy products and the best advi e are available, and every assistance on t whole practice of dairying is given from t cultivation of the soil, the growing of fodd crops, and the management of cattle, to t marketing of the finished products. Here Britain importers or experts supply reports to what Canada can best send here, and h comparative proximity enables her at on almost to respond to a rise in values. To st further develop her trade the Dominion G ernment have pledged themselves to con- ibute 750,000 dollars a year for ten years wards the establishment of a new fast tlantic service. With regard to quality anada "finest mild" cheese in the 12 months nded June 30th, 1895, averaged £2 7s. 6d. to 2 9s. 3d., or exactly the same as finest mild ew Zealand, finest mild Australian being enerally 2s. under this. Canadian went elow £2 in May and June, 1895, and for a rtnight New Zealand did also. Australian heese was sold at £2 in June, 1895. If it is ny satisfaction to know it home produce is uite as seriously affected here as in butter, e best cheese must be aimed at if the olonies are to live and prosper. There is no acancy in the English market for inferior heese, the supply is already more than the emand. Australasian cheese must come in at e top—and stay there—and it is all- mportant for the colonist to know it and do and for the purchasers here to be vare that good brands of New Zealand heese are reliable articles. The importance ere of skilled factory management with spect to the temperature of manipulation nnot be over-rated. There is unlimited pacity for making cheese in Canada; the quisite knowledge is imparted, the factories e numerous, the trade is encouraged, and e dairy cattle are of good stamp, whilst ove all food is cheap. In 1890, there were the provinces of Quebec and Ontario some 0 cheese factories, with an average of about 0 cows per factory. The produce of cheese s 1 lb. per 10·14 lbs. of milk, and the aver- e price of the cheese 9 cents and a all fraction per lb. In the same year the al cheese production of the colony was 4,981,514 lbs., of which 108,714,311 lbs. was tory made. In 1895, Canada, as will have en noted from what I said above, sent more an this figure to England. The increase we ay take it as a constant one, and it must be rne in mind that the figures of 1890 did not e Manitoba into account. A comparatively w departure has been made in Canada in fitting-up of cheese factories for manu- turing butter from October until May. undance of Indian corn can be grown to be as ensilage or weather-dried during the g and compulsory period of stall-feeding. is puts Canada on a more level footing with ntries situated in better climates, and bles a larger number of cows to be kept, d swine-rearing and fattening to be carried Canada is sending now a fairly uniform cheese, there being less difference than formerly between the qualities and values from different provinces. It is only for her now to take care that none "filches from her her good name," and tacks it on to parcels of "filled" cheese from another part of the same continent. A strict law against the fraudulent sale of anything as *cheese* but cheese from whole milk on this side of the water would be a benefit alike to the consumer here and the producer in the colonies.

New Zealand (export to United Kingdom in 1895, 75,430 cwt.; 1894, 45,398 cwt.; 1893, 37,043 cwt.; 1892, 25,583 cwt.)—The history of New Zealand cheese production has been one of steady and rapid growth. In 1893 New Zealand's export to England practically represented the whole cheese supply here from Australasia. The total from Australasia in 1895 was 92,759 cwt., as against 54,378 cwt. in 1894, and this was made up of a considerable bulk of Victorian cheese, as well as several thousand cwt. from New South Wales. New Zealand cheese fetches top prices, and ranks with Canadian, and the Dairy Act already alluded to ensures a certain quality being sent. The cheese is stamped by the Department of Agriculture, and also graded. The cheese is of fine cheddar make, and everything is in favour of New Zealand taking the lead in the market. Her climate enables her to send the best cheese here when the market most requires it. The most approved methods of make are now adopted; the co-operative dairying system helps the producer; and food and herbage are plentiful and cheap. None of the other Colonies have such favourable circumstances for cheese production as New Zealand. There are many districts in New South Wales and Victoria, that also are quite able to put cheese on our market equal to the Canadian. The climatic conditions are more favourable in New Zealand for the manufacture of cheese than butter, and when the factories are all thoroughly equipped and the best methods adopted throughout, New Zealand will take a leading place in the cheese supply. That this is so is not merely conjecture. The other day at the annual meeting of the Cheshire Dairy Farmers' Association a cheesemaker pointed out that the competitor Cheshire farmers had the most to fear in future was New Zealand.

Victoria (about 8,000 cwt. sent to United Kingdom in 1894, and 11,597 cwt. in 1895).—Progress in this colony has been astonishing in the dairy industry, but not so pronounced in cheese export as in butter. A year or two ago the Victorian Government with a view to fostering the cheese industry voted a bonus of 6s. per ton on all cheese realising £2 10s. per cwt. on the English market. Under this stimulus 400 tons were shipped in 1894 to England, but the cheese did not compare with the best New Zealand. The bonus system however has not been of so much advantage to the producer as might be anticipated, as the milk producer does not get so much out of his milk as the New Zealand farmer does, and the bonus system is taken advantage of by the few rather than the many. There are yet many faults in the handling of the milk prior to delivery at the factory, and in the packing, shipping, and consigning of the produce. More skill and knowledge in cheese-making is necessary in Victoria ere an average good article can be supplied. The experience, however, of the other colonies of New Zealand and Canada is being imitated by Victoria, and doubtless a large trade in cheese will eventually grow up. This is very desirable in Victoria, because when butter prices fall in the English spring, the Victorians ought to be in readiness to convert a gradually increasing quantity of milk into cheese, as during the English spring the prices obtainable for good cheese in England would enable the factories to pay a higher price for milk than they would be if butter were being made and sold at a low price. It is all a question of the quality and the uniformity of the product, and then Victoria will take a large share in the cheese supply of the old country. It would indeed be a desirable result if the development of the cheese trade in New Zealand, Victoria, and New South Wales were to oust a considerable bulk of the continental (Dutch) and the United States of America cheese from the English market. Victoria is perfectly well advised of all the requisites, and in a few years her cheese exports will follow closely on those of butter.

New South Wales (export to England, 1894, 1,150 cwt.; 1895, 6,268 cwt.).—The manufacture of cheese for export in New South Wales is yet in its infancy, although it has been abundantly proved that when sufficient care is exercised in making and shipping New South Wales cheese can find a ready sale in London at remunerative prices. There appears to have been no increase in the make of cheese in the colony since 1889, when Mr. Coghlan, the Government statistician, put it at 5,687,000 lbs. The same authority calculated the total output in 1895 at 4,820,412 lbs. In the South Coast district dairying has been a special feature of New South Wales agriculture f years. The factory system is replacing t dairy system, and those recently erected a fitted with every modern appliance. St great difficulties are experienced by the facto managers by the bad condition in which so of the milk is delivered. There is every pr bability of a considerable export trade cheese being developed; the essentials to t are now fully recognised by the agricultur department of the colony, and for some ti the home production of cheese has been excess of home needs.

MILK, CONDENSED OR PRESERVED.

	1893.	1894.	1895.
Cwt..........	501,005	529,465	545,400
Value	£1,009,755	£1,079,235	£1,084,55

The one unchallenged prerogative of t British farmer should be the supply of mi to the millions around him. Yet t monopoly is being gradually invaded, with t competition in the cheese and butter mar and the decrease in the home make of b it should be more and more the case t there should be pure milk at hand as beverage for those who would drink it. T ideal arrangement would be for England supply herself with milk altogether, and assisted by Canada with dairy produce summer, the Australasian Colonies supplyi dairy produce for winter, late autumn, a early spring. In addition to condensed m there has been an importation of 126, gallons frozen milk in 1895, worth close up £20,000. This is less than in 1894 by 34, gallons. Large quantities came into t country from Sweden in winter 1894-95, the trade is dwindling. New Zealand an importing colony as regards condens milk, and in 1894 received something li 530,000 lbs., of which Switzerland sent 140, lbs., the United Kingdom 362,390 lbs., Victo 9,640 lbs., and New South Wales 16,848 The present world's supply of this commod seems sufficient, but a demand would s cause the dairying colonies to be exporte In 1894 Canada sent about 100 cases condensed milk to Liverpool and with new departure of winter dairying, m be expected to develop the foothold this trade which she has obtained. C point both the Home and Colonial peop are interested in, is that condensed m shall be "whole milk" and not compete w fresh whole milk, nor endanger the lives fants by robbing them of the essential ement—"fat."

One of the largest purchasers of preserved ndensed milk is Cape Colony, which imports together 4,736,402 lbs., worth £92,590. This course is for transport "up country," where e production of fresh milk is impossible. It significant of the keen competition in dairy roduce that Denmark should be turning her ttention to the trade in frozen milk. A company, it appears, has been started at Copenagen for the regular export of frozen milk to ngland. A freezing plant has been erected, t a cost of £2,500, and a contract made for e supply of 110,000 lbs. of milk weekly.

It should be added that the bulk of conensed milk consumed in England is made ere.

BACON AND HAMS.

The pig follows the dairy and is the stand-by f the small farm. Great Britain's annual bill r bacon and hams is over £10,000,000; in 893 it was 11¼ millions sterling. Roughly, a uarter of that sum goes to Denmark; nearly alf to the United States, and about oneurteenth to Canada.

Canada received £500,800 for bacon in 1895 nd £185,000 for hams. She is extending this usiness with her winter butter-making as I ave shown. The Danish import is superior acon, equal to home cured, and commands est figures, wholesale or retail. Made on the o-operative factory system, by regulations at provide for good feeding and cleanliness, e method is one worthy of imitation. Canada as found it profitable to increase her export, nd the trade has grown. Canada's share in 887-89 was 1·63, of the whole in 1893-94 it was 2 per cent. and is now about 7 per cent.

Any export of bacon for Australasia at present is nominal. The pig fattening industry, owever, will follow the cheese factory, and in e near future must receive the close attenon of those concerned in the dairy industry. aving regard to the low prices of grain in New ealand, and its great value in the production f bacon and pork, together with utilisation of e bye-products for the dairies and factories, ere should be no difficulty in developing an nportant industry. The profitable use of the hey and butter-milk is too important a matter allow of it being neglected, and New Zealand acon would find a market in colonies and ountries nearer home than Great Britain. he New Zealand dairy experts have drawn ttention to this subject. Co-operation appears to be the method to bring this to a successful issue.

POULTRY AND EGGS.

The British farmer does not manage his poultry yard with a view to profit. An income of from £30 to £50 from poultry is too small a thing for his notice. As far as his supply of the market goes he supplies his own wants, and when he has too many he sells chickens and hens alive or dressed at a near market, and when everyone else is doing the same. The intelligent management on small holdings is little better, but there are large establishments that do an immense trade in poultry for the London market, rearing, buying, and forcing on economical principles. Yet in London and the large provincial towns there is a fine market for cheap good poultry, prices even in small provincial towns in England being very often prohibitive, even at the most plentiful time.

Let us see what Great Britain pays abroad for poultry. In 1894 our total bill was £480,884, France sending to the value of £222,909, Belgium £118,355, Russia £43,289, Holland £48,092, Germany £27,115, United States of America £6,444, Norway £6,661, Denmark £5,677, and Argentine Republic £1,122.

The total from foreign countries was £479,737, and the full total, which included a few odd lots from British possessions, was £480,884. In 1893 the total was £578,959, the falling-off being chiefly from France and Belgium. We may take it most of this is unnecessary if the old country and the Colonies did their duty.

The demand is an increasing one, as last year's figures will prove. The Colonies have got some foothold now as we shall show later on, but it is a small fraction of the amount of upwards of half-a-million sterling that Great Britain pays, as these figures show:—

	1893.	1894.	1895.
	£	£	£
South Australia	—	—	93
Victoria	48	221	4,791
New South Wales ..	13	—	131
Queensland	—	—	467
New Zealand	1,130	600	1,009
Canada	1,019	290	530

For "poultry, or game alive or dead," Great Britain's bill was £605,166 last year—

roughly £50,000 a month, or nearly £1,700 a day. Of this, £606,000, France claimed £261,500; Belgium, £126,000; Russia, £85,417; Holland, £49,318; Germany, £39,254; Norway, £10,610; Denmark, £7,523; United States of America, £9,523, &c. The value per head of population of these products has gradually increased, and (with rabbits) is now about 6d. per head of population, as against 4d. in 1885, and 2d. in 1875. So much for the appreciation of the imported poultry.

We may with advantage just glance at some of the methods adopted to supply the market—which is capable of much expansion—and then deal with the colonial supply.

Apart from Surrey and Sussex, Essex and Lincolnshire, and Ireland, local supply does very little for immediate needs, and is not apparently likely to do much more. The Sussex birds—a mixture of Dorking, Cochin, and Brahma—are collected from the country people by "fatters," or the larger "fatters" buy from higglers who have collected. The birds then are at once fasted until they are very hungry. They are fed from a trough on oatmeal and milk for a week, and no water given. Animal fat is added the next week, and from the fifteenth to the nineteenth day the birds are "crammed" twice a day. This is done by literally forcing soft food down their throats by means of a machine, an expert hand cramming fifteen dozen birds per hour. The birds, when sufficiently plump, are fasted overnight, and killed next morning; they are plucked immediately, trussed, the breastbone broken, and put into a press, to emerge a few hours after almost square in shape, and very solid. This method, on somewhat similar lines is adopted in other places in conjunction with rearing by incubators and hatching. In proof of the success of poultry fattening, eight out of ten of the Sussex and Kent fatteners make a profit and save money. In Ireland, with a stock of something like 16,000,000 head in centres round Cork, Kilkenny, Waterford, Wexford, and Armagh, a profitable industry is carried on. The average price to the large salesmen in Sussex we may put at 3s. to 3s. 6d., and over 1,000,000 fowls are sent to London and the south-coast watering places. Many of the birds for fattening are also bought in Ireland.

With regard to French imports which have slightly fallen off, it is said this is due to the high price of meat in France, owing to which, the natives are willing to pay higher prices for poultry than those obtainable in Londo This goes to show that the Colonies cou drive a good deal of the French import off th market, selling at a slightly cheaper rate. Th plan adopted in France is "forcing," muc on the same lines, chickens, ducks, gees turkeys are sent, and doubtless many sold English—as, indeed, the bulk of poultry retailed.

The poultry industry is an important one Belgium, for in that otherwise thickly-pop lated country it is estimated there are at lea 6,000,000 head of poultry, and that the annu value of the product of eggs and table poult exceeds £2,000,000.

There is no higher authority on poultry th Mr. Edward Brown, and we have his authori for saying that "a worse sample of fowl th the Russian can hardly be cooked, for yet b as they are, they find a market." The Russi Government intend to foster the industry poultry-keeping with a view of benefiting t peasantry. Even for Russian birds, the pric here are higher than they can get in forei countries nearer Russia, and considerab development of the trade has taken place, t imports of 1895 being double those of 18 Norway, Sweden, and Denmark are all i creasing their export, as are the Unit States.

The Colonies.—This being so, it will plain that the *Colonies' opportunity is no* and that it will be easier to gain a mark that is unoccupied than to have to displa rivals near at hand already in the field.

There is a good opening for a colonial tra in poultry in Great Britain, more especial from the Antipodes; but in all these ne developments, the first item to be consider is that of freight. Skilled dressing, prepar tion, packing, chilling, and storage of the be are necessary. It is satisfactory to know th with proper organisation there is already amp accommodation for freight of poultry, the tot being over 6,000,000 carcases mutton capacit while the requirements last year for mutt and sheep on all steamers and ordinary lar vessels to Australasia was only about 4,000,0 carcases. This leaves us about one-third the available space now for poultry, fruit, a products of petite culture that can be mo advantageously placed.

Canada is paying some attention to t industry; on the experimental farms of t Department of Agriculture there is a poult department under skilled management. Cana does at present little or nothing in the way pplying the large demand here, her export 1895 being worth £530.

In *New South Wales* the rearing and eeding of fowls for home consumption and arketing near the immediate neighbourhood carried on in much the same way as in igland. At present, the stock of fowls, icks, turkeys, and geese is about sufficient supply home use. The average price r pair was about as follows, 1894:—Fowls, . 3d.; ducks 3s. 4d.; geese, 4s. 9d.; rkeys (hen) 5s. 3d.; ditto (cock) 10s. 5d. ou will see there is plenty of margin here for port at profit as these are only about *half* e value at the best time in England. The st of freezing is put by a large firm at ⅜d. r lb.; and the freight 75s. per ton measure- ent of 40 cubic feet.

Victoria's stock and annual production of oultry is similar to that of New South Wales, id worth about £700,000. The Victoria epartment of Agriculture have given in- ructions for the exportation of poultry, and e colony is the richest in poultry of any of e Australasian Colonies. The rearing of oultry is increasing. Some 12,000 chickens id ducks were exported last year, about 500 turkeys and 88 geese. Good poultry iipped at the right season and sent in the ght way will command a price higher as a le than in Victoria, and if not that, at least profit. It is a question largely of freights id these latter depend upon the style and iality of the goods for shipment. In a few onths of the year shippers of poultry to ngland who have mastered the methods of lling, dressing, and packing, will find for ieir produce in England for a few months of ie year a better market for their surplus than ould possibly be obtained in Victoria. The epartment of agriculture have given the ecessary directions. Experimental consign- ents sent from Melbourne in winter 1893-94 onsisted of 11 crates containing 172 chickens, 4 ducklings, 64 teal, 36 black ducks, 4 irlews and 100 rabbits. The fowls and ucks were dressed and the teal and black ucks with their feathers. The packing was i this case far too bulky and expensive, the tal cost being £14 for the consignment. It necessary that each fowl should be frozen eparately, but half the space occupied by this onsignment would do. It is interesting to ote the prices realised:—108 chickens realised s. 9d. each, or 6d. more than the average rice given above as the value per pair in New outh Wales; 64 made 3s. 6d. each; 36 ducks realised 3s. 9d. each, or 5d. more than the New South Wales home value per pair; 8 ducks, 3s. 6d. each; 68 rabbits made 1s. 2d. each, and the balance 9d. each.

A second consignment later realised quite a shilling each more for the poultry, so there is room for profit here. Victoria's export to England in 1895 was worth nearly £5,000.

It is the same with poultry as all produce, the best alone proves remunerative to the shipper. What the Colonies must look to is to provide for the spring trade in England, and also for the large bird trade at Christmas. The trade would be a season trade and have to be specially catered for. As an adjunct to general farming managed on co-operative lines it will be very remunerative, and from Victoria's experience it is but a matter of time. Spring young chickens must be sent, and in May ducklings will bring good prices. Here again Australia has the advantage of the seasons.

Last Christmas Australian turkeys sold well, but it is to be borne in mind the poultry market then is flooded with supplies for Ireland, Canada, and the Continent. The Australian birds, however, command good prices, and these latter depend upon appearances. Prejudice against "chilled" birds there is none, and it is now at least in the matter of pheasants and partridges no unusual thing for private landowners in England who have ice houses to hang birds therein. A friend of mine enjoyed excellent pheasant in the first week of September last year that had been shot within a mile of the dining-table *ten months* previously. As an instance of what catering for and catching the market may do, I may mention that in Ascot week quite a quantity of Adelaide chickens were sold at 8s. a couple, and some as high as 10s. Many of these, doubtless, were sold as English, which were not procurable at the time by the Leadenhall dealers. The Australian turkeys this year have realised 9d. to 1s. 2d. per lb., but had they been bigger birds would have made more.

There is no doubt now that Australian poultry *sold as such* will be a permanent and well-appreciated feature of the food supply of Great Britain.

EGGS.

Imports to the United Kingdom are immense and growing:—

	1893.	1894.	1895.
No. (gt. hundreds) ...	11,045,986	11,876,098	12,722,292
Value	£3,875,647	£3.786,329	£4,003,440

First, it must be noticed that 831,000 great hundreds *more* eggs in 1894 than in 1893 brought £89,000 *less* money to the senders, whilst an increase of nearly 1,000,000 great hundreds in 1895 did not proportionately increase the total value, but, for the *first* time in our history, Great Britain paid *over* four million pounds sterling for eggs in 1895. The trade has gradually increased, and was under £3,000,000 a year in 1886, and first amounted to over £2,000,000 in 1873. Last year France sent eggs to the value of over £1,069,580, and Germany for 650,000 great hundreds *more* received for her inferior eggs £916,821, or £83,000 less. Belgium and Russia supply the next largest quantities, then Denmark, with an export worth £450,000, and Canada £156,653. Russia doubled her export of 1894 in 1895; it is stated that the demand is yet greater than can be fully met.

Canada appears, owing to her proximity, to have the best choice of all the Colonies to increase her trade in eggs with England. The Australasian colonies will never be able to compete with France and the nearer continental countries in the production of fresh eggs. At the same time a considerable trade can be established by an improved system of conveying eggs in cool chambers, and the Colonies should be able to compete successfully against Russian and Italian, and deliver better eggs and realise a higher price. Canada's experience shows this. She had virtually no trade in eggs in 1887-89; and since then has sent an average of 1,000,000 dozen per year. Further when worked out the figures show that the Canadian eggs made in the cheap year, 1895, 7s. 2d. per great hundred, as against 5s. 6d. made by the Russian.

The requisites for the colonial trade are quick collecting, careful handling, packing, storage, cool chamber space, and reasonable freights. In New South Wales, in 1894, the annual value at home was 1s. 3d. per dozen, and the production of 90,000,000 not sufficient for home consumption, and there was an import in the same year of 9,000,000 in excess of the export. South Australia supplies both Victoria and New South Wales with a quantity of eggs, and in 1892 exported eggs to the value of £27,771 obtaining a better market under the circumstances than would have been possible here. It appears that Victoria is rapidly becoming self-supporting in the matter of eggs, and should have a surplus for export this year. It is quite certain that shippers of poultry and eggs in Victoria will find the English market, at the right seasons the year, a better one for their surplus tha they could have at home. The colonial egg sent with care, would probably rank next the "crate" fresh eggs from France. The bul of the cheap Russian and Italian and Germa eggs are, doubtless, used for manufacturin purposes; and there is an export from Russi of large quantities of the yolks and whites eggs, as separate products, in tin boxes packe in barrels. The export trade in the Coloni would doubtless be best accomplished by son co-operative scheme, as in Ireland, and po sibly in connection with the factory system dairying. New Zealand, like Victoria, w have a surplus soon to export along wi poultry, rabbits, fruit, &c.

RABBITS.

For 10 years or more England has paid the foreigner an annual bill, on the average more than £300,000 a year, for rabbits for foo Indeed, to Belgium alone, for her big, tam fat rabbits, we paid £309,000 in 1889, ar £357,000 in 1890. Last year Belgium receiv £234,289 of a total rabbit bill of £315,585. T balance of over £80,000 was chiefly contribut to by France, £37,111; Holland, £21,81 Victoria, £15,737; New Zealand, £4,75 New South Wales, £1,755.

This is a distinctly new trade with Austra asia, and began virtually in 1894. The val of the export for the three colonies mentione was, New Zealand, £985, Victoria, £886, ar New South Wales, £182.

We sent Australasia the rabbit as a curs and she is returning it as a blessing, in t shape of food. To-day an English rabbit though no rarity—is a luxury even in t country places, and too dear a morsel for t average man with a family when selling over 1s., as it always does. Indeed, ab 2s. 6d. a couple is the average price in country town. In the Australasian coloni the rabbit has become a plague, as all of know; he has threatened to bring famine up a colony, and swept flocks and man bef him. All plans and premiums for his ext pation have failed. Now, however, that t Colonies have found him, as they do, profitable export, there is hope that his ve value and utility will destroy him as the sa quantities have destroyed nobler beasts. T importance of a rabbit trade to the Coloni then is two-fold. It is itself a source of pro and at the same time ridding the country of noxious pest. In this latter respect alone t portance of developing a profitable trade in ad rabbits cannot be over-estimated. It ust be borne in mind that the Colonial Govnments have hitherto paid large sums for his tirpation; it will be a gratifying result if e rabbit finally pays for his own execution d extinction.

The Colonial trade should easily capture e market here, and before dealing with a few the facts of the colonial rabbit supply I may int out that the colonial rabbit sent is a wild bbit like our own English rabbit, and not a shy "stall-fed" Belgian hare or rabbit. In is he is superior as a dish, by his numbers d cheapness in the colony he can be sold at ss money here than any rival, to pay the procer. Actual experiments in the market with cent imports, show that a shilling rabbit ings a good return, for they can be supplied holesale at under 8d. at this side. If people re, however, would take to the Australian inned frozen rabbit they could undoubtedly placed here at a cheaper rate.

Just now there is also a dearth in the nned rabbit trade, and these are becoming ry popular indeed as a Saturday night ing with the masses. Rabbits can be ry profitably tinned in Australia and New aland, and the skins and fur dealt with ere. The trade in rabbits for food frozen, nned, and all ways, will develop rapidly. hey can be packed perhaps more economilly as regards space than poultry in the ol chambers, and just now, owing to the ortness of freights of butter, some 200 tons frozen rabbits are on their way to England om Australia. The majority of the rabbits me frozen with the fur on, and when thawed t they cannot be distinguished from the nglish rabbit. There need be no fear of eir wholesomeness, for the colonial governents are as anxious that the trade should row as the English purchaser is to secure ood cheap food. All inferior rabbits and even ndersized ones are thrown away. When ey are what is called *dear* in Victoria they ake 5s. a dozen, but 3d. to 4d. each would be e average price, and perhaps less. Wholele here they have averaged close upon 1s., nd at that price will pay the colonial exporters ell. They are a wholesome, good, cheap od, carefully chosen, and equal to the best nglish rabbit. The Colonies therefore, when e trade is known, should be able to defy all mpetition.

In 1893-94 Victorian Government paid 20,687 for the destruction of rabbits on crown lands, and since 1880 some £300,000 has been spent for this purpose, and in 1894 it was estimated that 37¾ million acres were infested. Some ten million rabbit-skins, worth £55,000, were exported from Victoria in 1893, and in the year 1893-94 59,000 couples of rabbits were sold in Melbourne.

Rabbits spread from Victoria to New South Wales, some having been liberated in the former colony in the "sixties." By 1881 they had become a nuisance in New South Wales, and an Act of Parliament was first passed to provide for their destruction in 1883. By 1890 their destruction had cost the Colony £1,000,000. To-day the settlers' and farmers' holdings are protected by some 16,000 miles of rabbit-proof fencing. In New Zealand the rabbit has been equally a pest, and is energetically dealt with. His natural enemies, the stoat and weasel, have been let loose upon him, the Maories and others are paid so much for his skin, and other means have been largely practised. The pest appears to be held in check.

The essentials of the trade in rabbits are:—

1. They must be plump; quickly paunched after being killed, unskinned, and frozen hard.
2. They should be snared or trapped, and their necks broken.
3. Packed in crates holding three dozen, clean and uniform.

(Hares must not be paunched, but otherwise the same treatment does.)

4. Rabbits should be sent in large quantities from September to about the third week in April.

It only remains for me to say that if the Colonies can make any profit on every rabbit caught it will be so much more gain; for they will be paid then for what they have been paying others to do—killing rabbits.

FRUIT.

In no branch of production do our Colonies present such unrivalled advantages as in that of fruit. All the fruits of the temperate subtropical and tropical climates are grown in Australia. Canada, Tasmania, and New Zealand are unrivalled in their supply of apples, and their appreciation in England is most marked, for the barrels and boxes are packed with care, the fruit is sized and sorted, and careful shippers see that the quality is even all through. The demand is constant, for in the best of seasons the English crop of cooking and eating apples is virtually gone in three months after gathering, the orchard on the farm, and the treatment of its products being deemed less worthy of attention even than we have seen the hen roost is.

Careless handling, crude methods of storing, always assist the consumption of the English crop of hard fruit, and whilst apples may be given away for during a month in late summer, English apples for cooking or eating can hardly be bought with money when Christmas has arrived. For oranges, lemons, grapes, raisins and dried fruits, there is an ever-growing market here, increasing, too, *per caput* with the population. For preserved fruits (fresh), too, there is a more popular demand, tinned pine-apples, apricots, pears, &c., selling better yearly. Preserved (cooked) fruits are not in such demand.

Taking raw fruit alone, the British annual bill for the last three years has been as follows:—1893, £4,399,115; 1894, £5,510,265; 1895, £4,865,825.

In looking at quantities oranges and apples head the list, and, in 1895, the former cost £2,111,000 and apples £960,000. Imported grapes reached nearly £500,000, which may be taken now as the annual average sum paid. The bill for pears varies with the seasons. Last year it was only £166,000, but in 1894 it was £411,316, when English pears—which are more carefully kept for eating purposes than the bulk of apples—were plentiful. Plums only cost £166,045, so many not being bought for preserving, the usual figure being £300,000, and lemons cost a figure approaching £400,000. That the consumption of fruit per head has increased is evident from statistics. In 1876 it was below 2s. per head per annum; in 1886 it was 2s. 5d.; and now it is nearly 3s., and was 3s. in 1892.

There are in Great Britain some 218,428 acres of orchards; and they are increasing very slowly and, considering a trade in fruit, if we except pears in a good season, English competition may be neglected. Much development of English fruit-raising will not take place;—the difficulties are (1) the climate, (2) land tenure, (3) unprofitableness in most years. With regard to tropical fruits the Australian Colonies have great difficulties and disadvantages to overcome. Oranges are produced in California and Florida in excess of the demand, yet with the charges on them they cannot put them on New York market so cheaply as can their Mediterranean competitors with their cheap labour. With regard to grapes the disposal of this fruit by the Australian Colonies would probably be best accomplished by the manufacture of wine, or, as raisins. The app
trade promises the best, and with regard to t
more perishable fruits the whole question f
the Australian Colonies is the price at whi
they can place them on the English mark
against their Mediterranean opponents.

There is a means, however, in the Evap
rated Fruit Trade of disposing of Coloni
fruit. The "Fruit Evaporator" shown at t
Nottingham Royal Show (1888) is in comm
use in America, and, in 1887, 1,500 were
work near Rochester, chiefly drying apple
Mr. Dan. Pidgeon tells us that these find
market chiefly in Germany, England, Belgiu
Holland, and France. Evaporated apples a
placed in cases containing 50 lbs., and t
cost of carriage to Liverpool is 30 cen
(1s. 3d.). The same quantity of green fr
would cost from 8s. 9d. to 10s. carriage. N
damage is done to dried fruit in the longe
transit, and the advantage to Australia a
New Zealand from this fact alone are obviou
Apples, peaches, apricots, plums, cherrie
and raspberries are all treated this wa
and it is a big business in the district
Western New York. Vegetables can al
be treated the same way. In canning
fruit and vegetables there has been a va
development in America. The colonies the
have a well-established trade to meet in th
respect also. It should be stated that
canned fruit, Great Britain received in 18
34,897 packages of evaporated apples, 35,2
of canned apples, 17,798 of evaporated apr
cots, 15,343 of apricot pulp, 57,863 packag
of American canned tomatoes, and 9,640
French tomatoes.

Taking *Canada* first, the production of fru
and grapes, &c., increased from 45,957,0
lbs. in 1881, to 68,864,000 lbs. in 1891, or ov
50 per cent. The average export from Cana
alone to Great Britain in the years 1891
1893 of green apples was 2,005,000 bushels,
54 per cent. of the whole import of Gre
Britain, other British possessions only sendin
176,000 bushels. The drying and preservin
of fruits and vegetables is carried on in som
45 establishments, and the industry is increasing.

The cultivation of fruit in *Australasia* ha
not yet received the full attention it deserve
although the soil and climate are adapted t
fruit growing in all the provinces. Grape
oranges, apples, pears, and peaches are th
principal fruits grown, but with an unlimite
area suitable for this class of cultivation, an
the climatic conditions so varied, varying fro

mparative cold in New Zealand and the ghlands of New South Wales and Victoria, tropical heat in Queensland, a large variety fruits could be cultivated, and the industry ly languishes for want of a sustained de- nd. New South Wales has 45,000 acres der orchards and gardens.

The increased facilities for exporting fruit by adoption of cool chambers have enabled stralasian fruit growers to compete with eign States in the fruit supply for the Eng- h market. The Tasmanian trade with Eng- d has passed the experimental stage, and ery season large steamers visit Hobart to eive fruit for the home market. With the ception of Tasmania, at least up to 1892, all colonies imported more fruit and fruit pro- cts than they exported. The garden and chard crops of Queensland, Victoria, and est Australia give the most return per acre— m £24 to £20. In the other colonies, in 92, it averaged from £11 for New South ales to £19 for New Zealand. The small- ss of the average for New South Wales was plained by the fact that the producers could t get their produce sold and had no facilities disposing of it.

With regard to the irrigation colony at ldura of some 250,000 acres, the leading lustry is the production of raisins, all kinds fruits grow to perfection there, it is the posal of them that is the great difficulty in way of setting up a large trade not merely England, but all populous centres.

In *New South Wales* much intelligent interest now directed to fruit growing and indeed same obtains in Victoria and Queensland. New South Wales table grapes are grown about 2,400 acres, with an average yield about 2 tons per acre. In 1894, the land der *Citrus* fruits in New South Wales was 967 acres and in 1895, 12,204 acres. The rease is steadily progressive, markets are w sought abroad and the advantages New uth Wales posseses is that her oranges can delivered in London when the supply for ain and other countries north of the equator s ceased. Hitherto, owing to imperfect ying and bad packing the industry has not t with very great success. In 1894 the export oranges was estimated at 4,294,880 dozen. perience is being gained and faults learned actual practice are being corrected. It is ped to establish in time in connection with orangeries of New South Wales manu- turies for the preparation of candied citron non and orange peels, and for the preparation of the oil and essences of *Citrus* fruits. In 1894 the dried fruits from Mildura made a good impression on the English market, New South Wales, considering her advantage, imports far too largely all kinds of fruit, but she does a little intercolonial trade.

Victoria has recently opened up an experimental exportation of apples to Java and Sumatra, and shippers there consider that they have discovered an ideal packing material in the shredded bark of the tea tree. Passion fruit packed in this has reached London in an excellent state of preservation. The only thing that has hitherto prevented the colonies taking rank as large fruit exporters has been the inexperience of those engaged in trade. The area of orchards in Victoria has been increased by the bonus system from 40,419, in 1889, to 72,790 in 1893; and the fruit industry gives promise of becoming a large trade in the near future. In addition to the fruits of the British Isles, Victoria grows oranges, lemons, loquats, figs, persimmons, passion fruit, mulberries, melons, almonds, and olives. To encourage the export of fruit, also, Victoria, in 1895, gave a bonus of 2s. a case for green fruit of good quality grown in the colony, exported to approved foreign ports.

The Vegetable Products Commission of Victoria have given valuable attention to the Victorian fruit industry, and matters are progressing towards a considerable trade. Fruit canning is making progress also with the colony, encouraged by the bonuses, which latter will have had the effect of teaching people the trade if they have not created one.

Queensland produces fruit in its tropical climate to great advantage, and the return per acre is high and better than in any of the seven colonies. The department of agriculture in this colony is doing its best to develop a trade, not merely in fruit, but in tobacco, olive oil, coffee, sugar, &c. Instruction in the canning of fruit and other modes of exportation has been given throughout the colony, and with the extention of knowledge the export will come for the fruit is there.

South Australia is a vine country, and in 1894 about 10,000,000 vines were planted. The colony has passed a Vine Fruit and Vegetable Diseases Act to prevent the introduction of diseased trees into the colony.

At present the three great drawbacks to the Australian fruit growers are: (1) the excessive freight; (2) the large per-centage of loss arising through the fruit being canned without a proper system, and through the bad keeping qualities of the fruit when landed. New South Wales has shown how to meet these difficulties, and they must be met, for if fruit growing is to be a colonial business an export trade is a *sine quâ non*.

New Zealand has left no step untaken to develop an export industry. The Government appoints pomologists and instructors, gathers information about the demand in the home market, and all advice likely to be useful to would-be exporters. Generally speaking, all English fruits grow luxuriously, and in the Auckland district oranges, lemons, and limes flourish as well as olives, the manufacture of oil from which promises to be an important industry. Home grapes are largely sold in the Auckland market. The apple orchards near there have existed half a century, and yield returns of £40 to £50 per acre. Orchard planting is progressing, and must soon become an important industry. New Zealand has to some extent mastered the problem of landing fruit in a good condition in the London market, and the trade has passed the initial steps. It is important to notice that fruits of the proper varieties, and properly packed, have invariably realised remunerative prices. It is largely a question of packing and freights as to how great an extent the trade grows. Lemons have experimentally been successfully shipped to London. Demonstrations in the use of the fruit evaporators were given throughout the colony last year and excited much interest, whilst three specialists in orchard management travelled the colony and gave lessons in planting, pruning, spraying, &c. The Victorian viticulturist visited the colony last year and inspected the vineyards already established, and reported three districts as especially suitable for viticulture. New Zealand imports fruit largely, the value in the last return being £31,134 of dutiable fruit and £62,926 of free fruit. The colony appears to have made up its mind to alter this, but the value of fresh colonial fruit exported in 1894 was only £1,072.

It will be necessary to say little about fruit in *Tasmania*. Apples from that colony have become in England one of the most acceptable fruits for the early spring, though they were unknown to us here as an article of commerce prior to 1889. Expert advice on the varieties, the modes of packing, transit, and all details was sought. Then the market was sounded, fruit brokers approached, and the information sent throughout the colony. The mail companies assisted, and the fruit, on arrival, was inspected and reported upon. All th is unnecessary now; a sound footing f the trade has been secured, and Tasmani sent us last season 160,000 bushels apples. Some improvement, however, needed in distribution here for the grower declare that the London middleman swallow up most of the profit. Sympathetic distribu tion is needed here, at any rate. The trade i now launched, and the methods by which was accomplished might well be followed b the other Australian Colonies.

I have not hitherto referred to the Cape. I is an importing rather than exporting colon of perishable articles I have been dealing wit There was, however, for the Cape, an export fruit of various kinds, of the value of £2,41 in 1895, which was a considerable increas upon 1894. The Cape imports butter fair largely, and, as we have shown, a very con siderable amount of condensed milk, whic New Zealand could well supply. Victoria an South Australia have considerable trade wit Cape Colony, and from Natal the colon receives fruit to the value of £15,746. Ther is a small honey import from Australia.

WINE.

Australian wines are growing in popularit though perhaps not so rapidly as they deserve They have, to some extent, prejudice and hab to conquer, and, I may add, "fine old cruste customs." The cultivation of the wine is extending in all the colonies under notice, th vine having been first introduced in 1828 int New South Wales.

In Canada there are at least 6,000 acre planted, capable of producing 1,500,000 gallons of wine, and Ontario has an area suitabl for grape culture at least equal to half th present area of vineyards in France. Ontari is the chief vine-growing province. The industry began in some of the southern island in Lake Erie in the "fifties" and spread t the mainland on the Canadian side.

Vines are cultivated in all the Australia colonies and New Zealand. The climate an soil of Australia are peculiarly adapted to th successful cultivation of the vine, and with a increasing local demand, and a gradual appreciation of the wine in England, a future expansion of the industry appears assured. In South Australia, a large number of Germans are employed in the industry of wine-making. The acreage of vines in the different colonies, in 1892, was as follows:—Victoria, 26,443; South Australia, 15,418; New South Wales, 8,264

Queensland, 1,908; West Australia, 1,218; otal, 53,251. Victoria now produces nearly half the wine made in Australia. Taking an average year, the Australian produc-ion of wine may be put at 190 gallons per acre. Compared with the total wine production of other countries the total output of Australia is small, but the prospects of the industry are promising. It would appear hat if the wine is popularised in England and other countries on its merits it will demand a arge sale and the industry became very important.

South Australia especially has made great efforts to develop her wine industry with the nother country and has established a wine and produce depôt in London. At this bonded depôt the wines, after preliminary inspection and analysis, can rest, and care is taken that hey are put in sound condition on the Eng-ish market. Arrangements for the advan-ageous sale of the wines are also made. The tores were only opened in November, 1894, so hat the trade can hardly be said to be tho-oughly established. The result of the first ear's operations show the total arrivals of South Australian wine to be 1,700 hogsheads, which represents a contribution to the Customs f £5,300. The New South Wales wines took prizes at the Paris Exhibition of 1878, at Philadelphia, Sydney, Melbourne, and Amsterdam, and more recently at the Indian and Colonial Exhibition. At the Bordeaux Exhibition, in 882, in the centre of the wine trade of the world, the New South Wales wines were classi-ied by competent judges in the category of *Grands Vins*, and similar honour was given hem at Chicago. A difficulty is the palming ff of Australian wines as European. They possess excellent and distinctive characteristics nd should be sold as such. A large market waits them and only requires cultivation by accredited agents in this country. There are points in the management and the age that want attending to, especially the preliminary reatment of the wine in Australia, as at Bordeaux, with cool cellarage, fining, racking, nd blending for two years and a half or three ears prior to leaving the country. The total mports of Australian wine into the United Kingdom were:—1890, 314,000 gallons; 1891, 82,000 gallons; 1892, 461,000 gallons; 1893, 55,000 gallons; 1894, 399,000 gallons.

British South Africa sent in 1894 12,348 allons. The total import into Great Britain hat year was 14,368,621 gallons, of which France sent nearly 5,500,000 gallons, Spain 3,750,000, and Portugal 3,096,649 gallons. Holland and Italy sent a little more than Australia, and Germany about the same. There has been some decrease in the New South Wales export to the United Kingdom during the last two years. Phylloxera has damaged the industry in New South Wales and in Victoria, and deterred enterprise in the industry. The pest, however, is being dealt with thoroughly and in an energetic and enlightened manner. The Victorian Government voted £43,000 in 1894 for establishing a system of technical education by experts in—among other subjects—vine culture; wine making; fruit culture, &c. Vine growing is being pursued in New Zealand.

To sum up, the United Kingdom imports annually 14,000,000 gallons of wine. Australia only supplies 400,000 gallons and the New South Wales export has decreased. An improved system of marketing is needed. The cost of carriage and the heavy duty are serious items, but all the same, fair, remunerative prices can be obtained for sound red and white wines here if properly placed before the public. It would seem to be necessary that the Colonies should co-operate in this trade as a whole. First and foremost, the Colonies must take up the business of wine growing and wine making on scientific principles, applying special knowledge and trained skill both to the growing and the making. It all means capital expenditure, time, and money, and the Colonies as a whole could bear it better than singly.

HONEY.

This is an abundant product of Australia, and efforts have been made to encourage an export trade. The great drawback to a trade in this commodity which Australia can place at well under 6d. per lb. on the English market is the eucalyptus flavour and the dark colour. New Zealand sends an excellent honey free from the Australian fault, and it commands good prices. The Colonies must improve their honey in colour and flavour, and get rid of the heavy treacly taste, and substitute for it the delicate flavour of the clear Californian which makes top prices. All the fashion in England is for clear, bright honey, of home make; which, however, is very variable owing to the erratic climate. Bee-keeping is being scientifically taught in the Colonies, and New Zealand is advanced in this science. South Australia produces yearly about 600 tons, and could place honey f.o.b. at Adelaide at slightly under 3d. This should leave a good margin for freight and other charges. New South Wales produced honey and beeswax to the value of £31,006, Victoria £21,000, New Zealand £17,000, Queensland £10,000, and South Australia £9,000, in 1892. These figures have been considerably increased. Honey production is largely carried on in New South Wales, but honey is imported. The small shipments made to England have turned out unsatisfactorily, and the Australian product here has not acquired a good name. Good qualit honey, however, has always been found valuable here. The Victorian Government offere a bonus, and are supervising this export o honey in a systematic manner.

England's chief supplies (when she require any) come from Chili, the West Indies, California, and France (Narbonne honey). O the colonies, Victoria, South Australia, New Zealand, and Jamaica are the chief exporter to England.

IMPORTS INTO THE UNITED KINGDOM.

BUTTER.

	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
Channel Islands ...	509	481	329	319	458	326	246	310	251	28
British East Indies .	2,125	2,057	1,099	1,091	1,827	891	563	1,672	1,366	55
Australasia—										
South Australia...	—	59	175	—	409	282	—	1,825	1,492	1,351
Victoria	—	421	2,724	1,313	8,708	20,033	47,592	105,994	190,398	212,624
New South Wales	30	2,136	6,825	675	7,003	5,456	5,660	19,805	34,581	45,827
Queensland	—	—	—	60	60	—	—	—	—	—
New Zealand	101	3,585	15,801	14,267	24,318	28,647	34,268	41,815	65,626	52,27
Canada	31,522	32,673	9,307	22,732	15,195	46,273	59,571	43,160	20,887	38,94
Other British Possessions	4	3	1	14	9	2	4	26	6	738
Total British Possessions	34,291	41,415	36,261	40,471	57,987	101,700	147,904	214,607	314,610	353,608
Total Foreign Countries	1,509,275	1,471,719	1,635,172	1,887,371	1,969,730	2,033,907	2,035,105	2,112,867	2,260,225	2,472,074
Total	1,543,566	1,513,134	1,671,433	1,927,842	2,027,717	2,135,607	2,183,009	2,327,474	2,574,835	2,825,682

CHEESE.

	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
Australasia—										
South Australia...	—	—	—	—	—	—	2	68	—	—
Victoria	—	—	5	—	497	—	—	3	7,827	11,597
New South Wales	—	148	47	—	—	—	—	—	1,150	6,268
Queensland	—	43	—	—	—	—	—	—	—	—
New Zealand	8	10,126	26,946	—	28,495	29,702	25,583	37,043	45,398	75,430
Canada	508,112	632,886	668,335	—	837,890	857,841	1,038,599	1,046,704	1,142, 04	1,150,018
Other British Possessions	47	73	43	41	25	13	69	30	661	1,683
Total British Possessions	508,167	643,276	695,376	41	866,907	887,556	1,064,253	1,083,848	1,197,140	1,244,936
Total Foreign Countries	1,226,723	1,193,513	1,222,240	1,241,649	1,277,167	1,153,769	1,168,564	993,614	1,069,005	888,813
Total	1,734,890	1,836,789	1,917,616	1,241,690	2,144,074	2,041,325	2,232,817	2,077,462	2,266,145	2,133,809

POULTRY.

	1893.	1894.	1895.
British Possessions.			
ustralasia—	£	£	£
South Australia	—	—	93
Victoria	48	221	4,791
New South Wales	13	—	131
Queensland	—	—	467
New Zealand	1,330	600	1 009
anada	1,019	290	530
ewfoundland	5	7	—
ape of Good Hope	8	—	—
hannel Islands	55	29	23
dia	—	—	55
Total British Possessions	2,478	1,147	7,099
oreign Countries—			
Russia	34,123	43,289	85,697
Sweden	524	57	1,344
Norway	4,778	6,661	10,610
Denmark	4,022	5,677	7,523
Germany	32,959	27,115	39,254
Holland	44,457	48,092	49,318
Belgium	147,176	118,355	126,440
France	300,037	222,909	261,503
Italy	16	—	—
Turkey (Asia)	6	—	—
Egypt	—	9	6,513
Morocco	—	—	25
China	—	7	—
United States (Atlantic)	6,496	6,444	9,523
Argentina	1,887	1,122	311
Total Foreign Countries	576,481	479,737	598,061
Total	578,959	480,884	605,160

RABBITS.

	1893.	1894.	1895.
British Possessions.			
ıstralasia—	£	£	£
Victoria	—	886	15,737
New South Wales	—	182	1,755
New Zealand	82	985	4,745
ewfoundland	—	—	8
Total British Possessions	82	2,053	22,245
reign Countries—			
Germany	89	227	12
Holland	14,348	20,544	21,813
France	47,901	41,166	37,111
Belgium	82,436	85,978	86,057
United States (Atlantic)	—	—	115
Total Foreign Countries	144,774	147,915	145,108
Total	144,856	149,968	167,353

TOBACCO.

The three Eastern Colonies have given some attention to the growth of this crop, and samples of Australian tobacco manufactured here from leaf that had not been treated on the best methods was very similar, in the opinion of good judges, to the Virginian in flavour.

In 1892, the acreage was—New South Wales, 848 acres; Victoria, 477 acres; Queensland, 318 acres; total, 1,643 acres; produce, 12,810 cwt. Its growth has been tried in New South Wales, but has not gained any foothold. The area in Australasia, in 1881, under tobacco, was 3,184 acres, and in 1888, 6,641 acres. This has now dropped to 1,643 acres, the cause being that the tobacco leaf has not yet been prepared in such a way as to find acceptance abroad. Treated properly by experts from the very commencement, Australian tobacco should equal any other in ordinary use. It is much the same with tobacco as with wine. Attention is now being turned to it, with a view to an export trade, and the Governments concerned have taken steps to test the market, and get the opinions of merchants on the leaf. The samples submitted showed that the leaf was of suitable stamp for manufacture, but gave evidence of unskilled growth and treatment.

It would thus appear that Australasia has in her power a trade in tobacco in addition to supplying herself with plenty.

In conclusion it is shown that there is no important product of the soil that is one of man's necessities or has become a necessary luxury that Australia and her islands does not produce—meat, butter, cheese, milk, honey, wine, fruit and tobacco. Queensland and New South Wales grow the sugar cane, and the sugar beet is now attracting a good deal of attention in New South Wales and Victoria. Queensland was just able to supply herself and export a little sugar in 1892, and most of her surplus went to the other colonies. Her production of sugar in 1893 was 76,147 tons, and that of New South Wales 23,930 tons.

Garden and field crops of every kind grown here are in one district or another grown a little, but not largely as yet. In considering the capabilities of production of Australia in the articles of food supply, &c., that we have referred to, it must be borne in mind that much as the seven antipodean colonies do, agriculture therein has not passed the tentative stage. Mr. Coghlan, whom I have quoted before, says: "The typical Australian agriculturist, relying largely on a bountiful nature, does not exercise upon crops anything approaching the same patience, care, and labour that are bestowed by the European cultivator; nor, as a rule, does he avail himself of the benefits of scientific farming and improved implements to the extent that prevails in America and Europe." If this be so, and we receive produce so excellent, so varied, and in such quantity now, what may we not receive in days to come and near at hand! Producing everything that can be grown, could not Australasia with Canada alone in days to come supply us with all we now receive from Europe and that we could not produce ourselves!

DISCUSSION.

Mr. NIVEN, after expressing his appreciation of the value of the paper, said the conclusion of it seemed to lead to the inference that the object which Mr. Valentine desired to see attained was the ousting of foreign produce by colonial in British markets, as far as possible. This was a question which required careful handling, but there could be no doubt that, in the event of war, it was very desirable that we should be able to obtain our sustenance from our own colonies. Then there came the question—a subordinate one, no doubt—of relative cheapness; and there was also the question, whether it was not desirable to depend more upon what we could grow in our own country? How far it was possible to alter it, he did not know; but the continual laying down of arable land to grass, and the constant crowding of the rural population into the towns were a very alarming state of things which had prevailed for a long time. There was not much to criticise in the paper, but he should be disposed to take some exception to the good quality of the Australian meat. Having travelled in Australia and New Zealand, he could not agree that the former was a good country for producing beef and mutton, simply because the soil had not been properly tilled, and grass was of poor quality, the result being that you required to eat about a third as much again, in order to satisfy you, as you did of meat grown in England. He had heard a good deal about Australian wine, but it could not be compared with the best wines of Europe. Possibly the trade might be considerably developed, but he was not much disposed to hope for success in that direction. There was one point on which, perhaps, Australians might take advice, if they wished to develop their trade with this country, and that was, that they should take off the import duties on goods from here. He had travelled a good deal in Tasmania, which was a most beautiful colony, and might be called the garden of Australasia; but it did practically nothing in the gardening way, because it was so handicapped by the prohibitive Australian tariff.

Mr. YARDLEY said the paper demanded mos careful study, coming, as it did, from such a hig authority. On the previous evening he had bee looking at an old newspaper issued in 1792, in whic there appeared a letter from a correspondent in Ne South Wales, which stated that that colony wa then languishing for want of mortar and buildin materials. It showed what remarkable progress ha been made in 100 years that the same colony wa now sending home food for the mother country.

Mr. MONTAGUE NELSON thought there could b no doubt that everything possible should be done t promote inter-imperial trade, and he could not se that the desire to substitute colonial for foreign pro duce in the home market was anything to be ashame of. As had been pointed out, it was very desirabl that in time of war, we should be able to rely o supplies from our own colonies. He felt ver strongly on this point, and when there was scare recently with regard to possible complication with that great republic in the West, he wrote to member of the Government pointing out that we wer dependent on the United States for one-fifth our meat supply. One could hardly imagine wha the consequences would be if the supply were cut o suddenly. If trade were transferred to the Colonies and we had a powerful navy, the trade could be pro tected, and he could not see why England should b ashamed of expressing a desire that the trade shoul be transferred as far as possible, from foreign countrie to the Colonies. Of course it could only be done o equal terms, and it could not be accomplished all a once. The carriage of perishable articles and food fo long distances was a comparatively new invention, fo refrigerative systems had only been brought to any thing like perfection within about 12 or 14 years, bu that being now accomplished it should be the effor of everyone engaged in business, and of such societie as this, to promote inter-colonial trade. Wit regard to import duties no doubt imperial free trad was the right principle. Everyone believed in fre trade nowadays, and though we had not been s successful as was once hoped in carrying it ou throughout the world, it ought to be within th power of the statesmen, if they set their minds to i to bring it about within the limits of the empire.

Mr. W. G. TREWBY said the development of Ne Zealand was greatly hindered by the present mode dealing with land in the country. If anyone wen there and wished to settle he found nearly all th accessible land already occupied, and he could n purchase it for less than £10 or £15 an acre. H could get cheap land, no doubt, from the Government but there were no roads made communicating wit it, and it was no use attempting to produce foo for market when there was no means of access to it In America a very different course was pursued There a railway was made before the land wa declared open for settlement.

The **CHAIRMAN** then proposed a vote of thanks o Mr. Valentine for his extremely interesting nd valuable paper, which he could recommend or careful perusal. On the whole, he thought hey might congratulate themselves on the figures uoted, for though it was a serious matter to find hat Britain was so dependant on an outside suply of food, it was very satisfactory to learn that her wn sons across the sea were beginning to be such an mportant factor in the supply of her needs in this espect; and he looked forward with considerable ope to the time when our Colonies would, to a reat extent, supplant foreign countries in the supply f food to Great Britain. He considered that a egitimate principle to go upon, and he was quite atisfied that nothing had been done in recent times y a British statesman, which had given such satisfacion to the Colonial portion of our Empire as the lesire Mr. Chamberlain had evinced by his recent ircular, to improve the trade between the Colonies nd the mother country. If the food supply were to ome from the Colonies in time of wars, it could only e by fostering trade in time of peace. Such a trade ould only be built up gradually. The figures quoted vere very interesting, and considering that the butter, heese, and milk bill of this country was something ike £20,000,000, that we paid close on £5,000,000 or eggs, £500,000 for poultry, £350,000 for rabbits, 5,000,000 for fruits, and £10,000,000 for bacon, it vas evident that the Colonies had a good deal to do efore they could supplant the foreigner. There was ot time to answer in detail the question raised by Ir. Trewby, and he ought to say that he (the hairman) was not, as had been announced, the gent - General for New Zealand, as he had eased to fill that office a few days ago. Ie was not, therefore, present in any official apacity, but merely as a member of the Council f the Society; but he was asked by his sucessor to express his regret that he was preented by an important engagement from being resent. He would simply add, that Mr. Trewby ad not made an altogether correct estimation of the ondition of things in New Zealand. There was no ountry which offered such a favourable field for oung men of the proper class; and although, owing the large demand, land was sometimes difficult to btain, it was not so difficult as Mr. Trewby seemed suppose. The land tenures were very varied, and reat facilities were offered to small capitalists.

The vote of thanks having been carried unanimously,

Mr. **VALENTINE**, in reply, said there was very little rther to add, especially as the views he had put rward seemed to be generally endorsed by the eeting. With regard to the question of relative eapness, in his view, Australia and New Zealand d such facilities for the production of dairy proice, &c., that they could put them on the market ore cheaply than any foreign country. The first speaker did not approve the quality of the Australian meat and dairy produce; but he (Mr. Valentine) did not understand how he came to such a conclusion, for undoubtedly the best meat, poultry, and fruit imported from the Colonies competed very favourably with the best of home produce. With regard to wine, he must admit that it had not met with such general favour as the noted continental wines, but, at the same time, the wine possessed such body, and other characteristics of good quality, that, with a more general adeption of skilled knowledge in production, treatment, and marketing. it must soon become more popular.

INDIAN SECTION.

Thursday evening, March 26, 1896; the EARL OF DUNMORE in the chair.

The paper read was—

KASHMIR: ITS PEOPLE AND ITS PRODUCTS.

By WALTER R. LAWRENCE, I.C.S., C.I.E.

My paper this evening is entitled "Kashmir: its People and its Products." I shall not dwell at any length on Kashmir's chief charm —its scenery, for at the close of the paper I propose to show you photographs which will depict more vividly than words the scenes which delight all visitors. These photographs are the result of the patient and laborious work of my friend Mr. Millais. I can vouch that they are accurate and instinct with the very spirit of the valley. Mr. Millais's name will be sufficient guarantee that the photographs are artistic.

I must, however, say a few words about the scenery and the configuration of the country. The beautiful valley is cradled in the Himalayas at an average height of 6,000 feet above the sea. North, east, and west, it is shut off from the outer world by range after range of mighty mountains, while on the south it is separated from the British province of the Punjab by rocky barriers 50 to 75 miles in width.

The valley, that is the cultivated part, is 84 miles in length and 20 to 25 miles in breadth, and from the south to north and north-west it is traversed by the great river which we call the Jhelum, the Kashmiris call the Veth, and the ancients called the Hydaspes. The delta of the river in Kashmir is the Wular lake, a beautiful sheet of water covering some 80 square miles. In its course through the valley the river flows gently, and Horace's words, "lambit Hydaspes," are the best description of the smooth, easy current of Kashmir's great waterway. But when the river reaches Baramula it leaves for ever the grassy banks of the valley, and hurries down its rocky, torrent course to the hot plains of the Punjab.

In the valley, wherever you look, you see mountains, ever varying in shape and colour. There is the grim Haramak, which guards the entrance of the Sind Valley. It was my North Pole, to which we laid our maps when a compass was not handy. There are many legends clustering around Haramak, and the natives say that the presumptuous mountaineer who dared to scale the snow peak would meet with instant death. In the crest of the mountain there is said to be a vein of emerald which renders innocuous all snakes which lie within its ken. It is a curious fact that the poisonous snakes of Kashmir only occur in valleys which are hidden from the eye of Haramak. All around the valley are well-known peaks, all rich in legends, and above all towers the grand promontory of Nanga Parbat (26,620 feet). The sad fate of Mr. Mummery lends a painful interest to Nanga Parbat.

I suppose that all dwellers in a valley who watch great mountains, with their clouds and thunderstorms, are more prone to superstitions and legends than the people who live on the great plains of India; and I attribute much of the superstitious element in the Kashmir character to the daily contemplation of mountain scenery in its most finished form. The colouring of the mountains is exquisite. In early morning they are often a delicate, semi-transparent violet relieved against a saffron sky, and with light vapours clinging around their crests. Then the rising sun deepens shadows, and produces sharp outlines and strong passages of purple and indigo in the deep ravines. Later on it is nearly all blue and lavender, with white snow peaks and ridges, under a vertical sun; and as the afternoon wears on, these become richer violet and pale bronze, till the last rays of the sun have gone, leaving the mountains a ruddy crimson, with the snows showing a pale creamy green by contrast. You descend from the mountains, you leave the glaciers fringed with the useful birch tree, and descend to grassy glades surrounded by deep forests of pines and firs. Down through these forests fall streams white with foam, passing, in their course, through pools of the purest cobalt. Then you come to villages and terraced cultivation, and lastly to the level stretches of the varied coloured rices. Everything in Kashmir is rich in contrasts. The East blends with th West. The delightful plane trees, the magnificent walnuts, the endless willows, th poplars and elms, the wealth of mulberrie and the countless orchards of apples, pear and apricots will remind you of a well-woode English park. But the crops—the rice wit blooms of art colour, the sulphur petals of th cotton, fringed with the scarlet of the ama anth (our "love lies bleeding") are of th East. The rounded forms of the trees, th rivers and streams with their banks of gree turf and willows recall the West.

The very villages are almost English. Li our Saxon ancestors, as described by Tacitu "suam quisque domum spatio circumdat, and instead of the ineffably dreary and u villagelike look of the Indian hamlet, we ha in Kashmir the picturesque homesteads dotte about here and there. All have their litt gardens and courtyards. Near the cottage the wooden granary—not unlike a huge sent box. In the courtyards the women are pound ing the rice and maize, and the cotton whe is for the time laid aside. Dogs are sleeping and little children are rolling in the sun, whi their elder brothers—also children—are awa looking after the wild cows and cattle. Mo villages have a delightful brook, on which a quaint-looking bathing-house, where th villager leisurely performs his ablutions. O of the prettiest objects in the village is th graveyard, shaded by the Celtis Australis an bright with iris—purple, white, and yellow- which the people plant over their departe relatives.

Time will not allow me to describe th beautiful lakes or the mountain meadow known as Margs, where English visitors li in pine-wood chalets on the fringe of th forest. The lawns and flowers which natu gives would make most gardeners pause. N can I tell you of that loveliest angle in th world—the Dal lake, with its beautiful par and gardens, reminiscences of the Mogh times. All I can say is, that Kashmir ca be reached in three weeks from London; th it has a most delightful and varied climat and that for a holiday or change there can b no more restful and healthy life than a year six months' sojourn in the valley of Kashmi The *Dolce far niente* existence in the hous boats on the river and lakes, or, still better, th gipsy life in the tents would give a new lea of life to many. You will meet with the kin liest welcome from the ruler of the country an his officials; and if you happen to have a med ine chest with you, you will be received with cclamation in the most secluded villages. I ave often come across English ladies camping by themselves, which speaks well for the ourtesy of the people and the safety of the ountry. Whatever your tastes are you satisfy hem in Kashmir. There is sport, excellent nd varied; there is scenery, ah! such scenery, or the artist and the layman; mountains for he mountaineer; glaciers for the botanist; vast field for the geologist; and magnificent cenes for the archæologist; and you can live ell in Kashmir on £200 per annum. Go, if ou can, in the early spring, in order to see hat marvel of colours, the blooms of the lmond groves, and the pink and white promise f the orchards. To enjoy Kashmir, as indeed o enjoy anything in the East, you must enter nto the spirit of the hemisphere; you must aunter, and ignore time. If you rush on, rom one camping ground to another, you will niss many a point of natural charater which night interest and amuse you. And I think he Kashmir people are worth some study.

Up to the end of the 14th century, Kashmir vas the seat of a Hindu kingdom strong nough to interfere in the politics of India. The old temples tell more vividly than words hat these Hindus were men of grand ideas. Then, by preaching or persecution, the people eft their glorious temples and their picturesque eligion for the poor and sullen compromise of slam. At the end of the 16th century a urther change awaited the Kashmiris. The eauty or rumoured wealth of the valley attracted the adventurous Moghals, and after bstinate fighting in the difficult passes, Kashmir came under a foreign yoke. These grand Moghals loved the valley; they built "sunny leasure domes," such as Coleridge dreamed f in "Khubla Khan," and they planted the oble plane tree. They have bequeathed to osterity the love stories of Selim and Naurmahal. On the whole, the lot of Kashmir vas not unhappy in the Moghal times, and the eople still speak with affection and admiration of the Emperor Jehangir and his lovely onsort, the "Light of the World." But to he Moghals the brutal and oppressive Pathans ucceeded. Give a Pathan a chance, and he s a bully and a fiend. He had his chance in Kashmir and he ruined the country and the eople. The Pathan was driven out by the ikhs. It was a change for the better, but the ikhs left much to be desired. Moorcroft, who travelled in Kashmir in the Sikh times, ells us that the punishment for the murder of a Kashmiri by a Sikh was a fine of two rupees. Crossing a pass, he came upon a young man whose throat had just been cut, and saw three other corpses, "some of the followers of a native official who, to the number of 45, had perished in crossing the path lately in rough and cold weather, against which they were ill-defended by clothing or shelter. Some of the people accompanying us were seized by our Sikhs as unpaid porters, and were not only driven along the road by a cord tying them together by the arms, but their legs were bound with ropes at night to prevent their escape."

In 1846—just 50 years ago—we made over Kashmir to Maharaja Gulab Singh, chief of the warlike Dogras, a Hindu. He was a stern, strong ruler; feared and respected by the Kashmiris. His methods were Oriental and effective. Kashmir was full of bandits, and Gulab Singh made up his mind to stamp out crime. He made each punishment an object-lesson. I have heard from eye-witnesses many of Gulab Singh's endeavours to make punishment deterrent. A soldier had murdered a child for the sake of her jewellery—a common form of crime even now in India. Gulab Singh sentenced him to hard labour on the road. Months after Gulab Singh happened to be walking along the road on which the criminal soldier was working. He asked him how he was progressing, and the man, encouraged by the affable manner of the Maharaja, said, "Don't you think I have been punished enough for my little offence?" "I quite forget what it was," said the Maharaja. On hearing what the offence was, the Maharaja mused, and then called to a carpenter who was working on a bridge. He then demanded a pen and ink, and removing the criminal's clothes, he carefully marked his body into four parts. "Now," said he to the carpenter, "saw him in four pieces, and send a piece to each of the districts. I will show the people that I do not consider child murder a little offence." These punishments have had their effect; crime is non-existent in Kashmir. Within the last ten years only one Kashmiri has suffered capital punishment. The people are afraid to commit crimes.

You will see that Kashmir has undergone many changes in its governors, and there is a deep-rooted disbelief in the continuity of affairs. The governors and their deputies have, unfortunately, felt no sympathy for the people, so that the Kashmiris are hopeless of benevolence or justice in their rulers. It has been the deliberate policy of the Brahman officials of Kashmir — known as the Panchits — to exaggerate the difficulties of administration in the valley. They excused their own corruption, cruelty, and ignorance by assuring their masters that the Kashmiris were lying, lazy, and dishonest. No dog has ever been given so bad a name as the Kashmiri serf, and I was solemnly assured when I began work in the valley, that fair and humane methods would lead to a revolution and to the depletion of the treasury.

Apart from the evil effect which cruel and unsympathetic governors have worked on the timid character of the Kashmiri, other causes have conspired to make him doubtful and hopeless. Kashmir is a country where nature rejoices in her strength. Earthquakes, floods, fires, cholera, and famine are familiar to every generation. Take one village as an example. In the village of Pattan there is a normal population of 165 families. In 1885, 70 persons perished in the earthquake. In 1892, 55 persons were carried off by cholera. This is enough to unsettle strong-minded Anglo-Saxons, and with the tyranny of man on the one hand, and the terrible vagaries of nature on the other, the Kashmiri has become incredulous of the existence of good in man or in nature. He always gives me the impression that he has just recovered from a fright, or that he is expecting some disaster. They have sad memories; their very songs are those that look back to a melancholy past and forward to a melancholy future. Hardly a day passes without mention of the great famine of 1877-79, when men turned cannibals, and three-fifths of the population is said to have perished. The Kashmiris sigh as they quote the proverb "Drag tsalih, tah dág tsalih na." The famine has gone, but its stains remain.

And though famine has gone, I hope and believe never to return, and though tyranny, torture, and the *corvée* have gone, their stains remain, and we must make allowances for faults in the Kashmiri character.

They are timid and somewhat effeminate. They wear a womanly dress. A kind of heavy woollen nightgown falling to the feet. Under this, if it be cold or wet, they insert a small earthen brazier of hot embers, known as the "kángar." This keeps them warm, but it has its drawbacks. They go to bed with their kángar, and set the house on fire, and it is said that the brazier is a fruitful source of cancer.

They are lazy when they have no interest in their work, but when they are working for themselves they are most energetic and eff cient. Up to quite recent times no one ev knew that he was certain of reaping the frui of his labours. Their simple propositio "Yus karih gonglu sui karih kráo," he wh ploughs shall reap, was ignored at harve time, and everybody took what he liked. Ever thing was taxed, and the farm of a tax oft brought with it social distinction and som times wealth. It was part of my business put down the soldiers of fortune roving, oft without a commission, to collect taxes violets, birch bark, or some medicinal herb. explained to them that there was not room f them and for me, and that violets must bow the land revenue. With officials plunderin and hordes of tax-farmers, real and fictitiou with regiments of soldiers whose sole duty was to assist in collection, it is no wonder th the Kashmiri took refuge in lying and su terfuge. When face to face with the Pan officials the Kashmiri villager will urge case with the fervour of St. Paul and the accuracy of Ananias; but remove the officia and set him up before his fellow villagers, a the Kashmiri will speak the truth. It is grave charge to bring against a nation say that it is a nation of liars, and after years' constant intercourse with the people the villages, I can say that the charge is true. All cases connected with land came und my jurisdiction, and it was my practice hear these cases on the spot. The Kashm was ashamed to lie in the presence of neighbours. If he did sometimes lie, th was a telegraphy in the eyes of the men w stood around which gave a quick clue to truth. The parish council of white-beard elders was to me a most useful institution. I do not say that the Kashmiris are an exe plary people, but I do say that they have ma excellent qualities; and I maintain that, un a just and sympathetic Government, th might grow into a fine, manly nation. Th are intellectual, dexterous, and witty. Th can turn their hands to anything. There is cultivation in Kashmir that would aston Europeans; there are art wares in Srinag that have astonished the world. The mean peasant likes to display his wit, and every d I heard some shrewd, humorous remarks.

In their domestic life they are admirab One never hears of scandals. Like the Ir they are kind to their children and the folk. There are many points of resemblan between Kashmir and Ireland. Both small countries, which have suffered or deri enefit from the rule and protection of more owerful nations, yet have never welcomed any hange or improvement. Both Kashmiris and ish love a joke, are fond of harmless deceit, nd are masters of good-humoured blarney. oth have the same deep-rooted objection to aying their rents.

The Kashmiris are a very gentle people. hey quarrel but never go beyond invective of buse. The sight of blood is dreadful to them, nd in some villages if a fowl has to be killed r food the execution devolves on the village riest. But in invective they are past masters. ou will hear two women quarrelling from eir respective boats. The men sit quietly njoying the scene of the noise. For hours e shrill abuse continues, and when evening omes and the women are hoarse they rise nd invert their rice baskets. This is the sign at the fight is over for the day, but at early orning the baskets are set up again, and the ordy war begins afresh. People talk of illingsgate, but commend me to a Kashmiri rago. The Kashmiri is loud and voluble hen he thinks that he has been injured by an. A common expression is that he will ake himself heard as far as London. Somemes when I had the misfortune to give a ecision regarding land against a man who ere and then lifted up his voice and said he ould proclaim the injustice of my order as far s London, I have taken him aside to ask here London was. The inevitable answer as "London, as your honor knows well, es beyond Sukkur Bukkur on the Indus." his was the *ultima thule* of Kashmiri easants' thought. They are a people of yperbole and symbols.

Formerly, it was no doubt necessary to tract the attention of their rulers by some riking demonstration. Men who have a rievance will fling off their clothes and smear emselves with mud. The nakedness implies estitution: the mud signifies that they are duced to the condition of a clod. Many a me I have seen a procession: one man wears shirt of matting; another has a straw rope und his neck, with a brick pendant; another rries a pan of hot embers on his head; while the rear comes a woman bearing a number broken earthen pots. This was bad, but ore inconvenient was the practice of casting plough under my horse's feet, as I rode ong, in order to emphasise the fact that griculture no longer possessed charms for the oprietor of the plough.

Once, as I was hearing petitions, I noticed an elderly Hindu standing for at least five minutes on his head. No one took any notice of him. At last, fearing the old man might injure himself, I had him placed on his feet. When questioned as to his attitude, he said that, thanks to my arrangements, his affairs were so confused that he did not know whether he was standing on his head or his heels.

A man once came to me carrying the corpse of a child, and alleged that his enemies would not allow him even burying ground. He had a land suit in his village, and he wished to strengthen his case by arousing my indignation. Once a man appeared at Nágmarg, a place some 9,000 feet high; he was stark naked, and said that his uncle had turned him empty into the world. It was bitterly cold, and night had fallen, so I gave him a suit of old clothes, and, by way of jest, said that, as he was now dressed as an Englishman, he should assert his rights. He shambled down the mountains, and next day the uncle came into my camp, charging the nephew with an aggravated assault, and offering in his shattered appearance convincing proof. It is always dangerous to jest with Kashmiris.

The ruler of Kashmir is a Hindu. Over 93 per cent. of his subjects are Mussalmáns. The officials of the country for the most part belong to the rigid Brahman caste. But the oppression in Kashmir, which up to quite recent times formed the text of newspaper articles and books of travel, was entirely official, and did not arise from religious intolerance. There has of late arisen in India a spirit of revivalism in the two great religions of Brahminism and Islam. In Kashmir, however, Mussalmáns and Hindus live together in delightful amity. One reason of this charming tolerance is the fact that beef is never heard of, and kine-killing is an offence punished most severely. But the chief reason is that the people of the valley, Mussalmáns in name, are at heart Hindus. The religion of Islam is too abstract to satisfy their superstitious cravings, and they turn from the mean priest and the mean mosque to the pretty shrines of carved wood and roof bright with the iris flowers, where the saints of past time lie buried. The Kashmiris are nicknamed in the East the "Pir Parast," or Saint-worshippers. They believe that "the saints will aid if men will call," and regard a dead saint as more efficacious than a living priest. All that there is of adoration and reverence in the Kashmiri character expends itself on shrine worship, and the poor priest and the ruinous mosque are neglected until cholera or some great calamity comes. Then Islam raises its dead ; and in cholera time, I have heard the priest addressing the silent, frightened crowd as they sat helpless in the graveyard. He used King Solomon's very words at the dedication of the Temple—

> "It there be in the land famine, if there be pestilence,
> Then hear thou in heaven thy dwelling place, and forgive."

The voluble Kashmiri is silent when he knows that his troubles are not of human origin. I was in Srinagar, in 1892, when the daily death-rate from cholera had risen to 500. I was struck by the hushed silence which had fallen on the famous City of the Sun. A native friend explained it. A Panditáni had lost a son, and mourned loudly. A spirit appeared and taunted her with wailing for one son, adding that before night she should have real reason to mourn. Before night she had lost her husband and her two other sons. No one wailed after this. Kashmir is rich in superstitions, and lovers of the supernatural will find a grand field in the villages of the remoter valleys. Night after night as I sat by the camp fire I would hear the quaintest and most stirring legends. Demons on the mountain passes in the shape of fair women, dragons in the deep-green lakes, which are found on the higher ranges—underground rivers and an underground world where the serpent gods hold sway, divining springs, and trees of ordeal—and caverns where men controllers of the wind live their solitary responsible lives. The Brahman astrologers of Kashmir are famous in the East, and the wild soothsayers of the valley have an immense reputation. It was curious to have daily business with clever, shrewd farmers and officials, all absolutely believing in these old-world superstitions. But the things dreamed of in the Kashmir philosophy date back to the times of the old saints, and the Kashmir mind, keen and intellectual in mundane affairs, is in things spiritual slumbering in the beautiful old shrines.

I must now leave the people, and say something of the products of the valleys. Agriculture was my chief pre-occupation, but it would not interest you to hear about our staple crop, the rice. It will be more interesting to know that almost all the vegetable products that exist in a temperate climate can be grown in the vale of Kashmir. It is my hope and ambition that Kashmir may become the California of India. Our fruit is magnificent, and it comes to us so easily. We have everywhere an endless supply of wild stock, and from our nurseries we give out thousands ar thousands of trees grafted or budded with tl best English and French varieties of apple and pears. A tinning industry was intr duced two years ago, and is thriving. W have large vineyards, from which excelle wine—Médoc and Barsac—is made. W have recently replanted these vineyards wi American stock in order to combat th phylloxera which has penetrated even remote Kashmir. We have made excelle cider, and the brandy which we distil from th wild apples and pears is pure and potent, ar is the one spirit drunk by the natives of th city. We have succeeded admirably wi hops, and the financial results would surpri Kentish growers.

But our great hope lies in sericulture. Sil is an ancient industry in Kashmir, and it probable that the valley was a producer of th old Bactrian silk which found its way Damascus and other centres of manufactur But evil days befell silk, and in 1878, di ease obliterated the industry. In 1889, whe I first went to Kashmir, it was decided, on th advice of Sir Edward Buck, C.S.I., to r habilitate sericulture, and to stamp out diseas by following the Pasteur system of micr scopical examination. For the first two yea it was difficult and disappointing. A nati with a microscope is a most uncertain com bination. But eventually we succeeded, and few weeks ago the first Kashmir silk found sale in London. As regards its quality, expert can speak . I can only say that, being a amateur, I have advised the State not to incu expense on improved reeling appliances, an my object has been to make sericulture pay it expenses, and to demonstrate that good sil could be raised in Kashmir. I can give you n good idea of the wealth of mulberry trees tha are wasting and waiting for the silkworm. I ca only say that European capitalists will find i Kashmir the elements which contribute t successful sericulture. The Kashmiri house i eminently adapted for the rearing of silkworms ; there is abundance of skilled labou in the presence of the "Kirm kash," or worr destroyers, families with an hereditary connection with silk ; and, above all, there is an endless supply of mulberry leaf.

All that is wanted to realise my dream c an Indian California is European capita and European skill and energy. Alread Europeans are carrying on a profitable business, as manufacturers of carpets, and thei capital and supervision have proved of grea ssistance to the unfortunate weavers of the ld shawls, for which Kashmir was once amous throughout the world. The French nd German war destroyed the shawl trade, nd the poor weavers, too soft and too sedenary for agriculture, would have perished, had t not been for the carpet trade.

Everywhere we have splendid water power, nd, if capital were forthcoming, cotton mills ight be erected which could supply Kashmir nd Central Asia with cloth. Our local cotton s excellent in quality, and the cloth of the and looms is preferred to the piece-goods rom India. It wears longer, and is better alue for the money. Then the valley abounds n fibres. One of these is especially worthy of uropean notice; we call it Yechkár. This, he *Abutilon avicennæ*, and its fibre, has een pronounced superior to Indian jute and ner than Manila hemp.

The people of Srinagar are born artizans, nd the European capitalist will find apt men, f all handicrafts, ready to hand. Just as the ashmiris prefer the home cotton cloth, made ocally, from the native cotton, so they prefer he iron of Kashmir to the imported metal. It as described to me by an expert, who held ost sanguine views as to the future of Kashir iron, as being equal to mild steel. Many old that the valley and the mountains which urround it are rich in minerals; and the hance discovery of the rich sapphire mine in 882 suggests that organised exploration ight result in further discoveries. As I ave pointed out in my book on "Kashmir," is a mistake to suppose that the natives of the alley would be eager to disclose the existence f rich lodes. They are an agricultural or astoral people, and their experience in the ast teaches them that the discovery of mineral ealth is attended with drawbacks, in the ape of forced labour and of numerous officials ho must be fed. I have often discussed the uestion of iron mining with the villagers who ve near Sof, the chief iron field, and if their ews on the subject of mineral wealth reprent the general ideas of the people, it is no aggeration to say that the Kashmiris detest e very name of mining.

Time will not allow me to tell you of the oating gardens of Kashmir, like the Chinmpas of old Mexico; nor can I tell you of the ffron fields, for which the valley is renowned. he author of the "Ragatarangini," the mous Sanskrit history of Kashmir, who gan to write in 1148 A.D., alludes to the ffron in his introduction.

"Kashmir is a country where the sun shines mildly, being the place created by Kashayapa as if for his glory. High school houses, the saffron, iced water, and grapes, which are rare even in season, are common here. Kailásá is the best place in the three worlds; Himalaya the best part of Kailásá; and Kashmir the best place in Himalaya."

I agree with the old chronicler, and I think that any of you who can find the time to visit Kashmir, will also agree that it is the best place in the world.

DISCUSSION.

The CHAIRMAN said they would all agree with him that they were very much indebted to Mr. Lawrence for the most interesting paper he had given, and especially for the beautiful photographs he had shown—taken by Mr. Millais. With that modesty which was so often characteristic of a successful career, Mr. Lawrence, although he dwelt on the great and important reforms in Kashmir, did not tell them that most of those reforms were brought about by his own instrumentality. He might say, however, that, supported by the Maraja and his councillors, Mr. Lawrence had effected what could only be described as a social revolution in Kashmir. During his tenure of office, many of the old and undesirable customs had been modified, and, in many instances, swept away altogether, and radical changes introduced. Ignoring the obsolete traditions of an ancient native administration, Mr. Lawrence, in the treble capacity of judge, jury, and arbitrator, actually decided law suits which the natives, of their own free will, withdrew from the ordinary Courts, and brought to him for his decision. The result of his unremitting labours during the last six years was patent to any traveller of ordinary intelligence who kept his eyes open. Those wanderers who, like himself, had journeyed through Kashmir from one end to the other, could not have failed to see that the people were, for the most part, in a happy and contented position; and more land was annually being brought under cultivation, and the revenue was in a more flourishing condition than ever before. Mr. Lawrence had, therefore, achieved a great work in that country, and future generations of Kashmiris would revere his memory as much as the present generation appreciated his successful endeavours to ameliorate their condition. That condition was formerly one of unjust assessment, the farming of taxes, and the embezzlement of large sums of money, which were constantly entered as arrears against various districts. The result of this farming system of extortion and oppression was the abandonment of their holdings by the small cultivators and zemindars, and an increase in the already congested population of Srinagar. The condition of the people had now been very greatly improved; agriculture was on the increase instead of on the wane; and as former oppressive taxation of the subject was a thing of the past, so the augmentation of the revenue was the state of things at present. He could only say that, knowing something of Kashmir, he had listened with the greatest interest to what had been said, and he was quite sure they would all join in passing a hearty vote of thanks to Mr. Lawrence.

SIR GEORGE BIRDWOOD said that at that late hour all he had to say on the paper generally, before especially remarking on the paragraphs devoted by Mr. Lawrence to the products of Cashmere, was to express his entire concurrence with the eulogium passed on it, as also on Mr. Lawrence's work in Kashmir, by the noble Chairman. Mr. Lawrence had provided them with a brightly-written and charming description of Kashmir, to which they had all listened with delight, few of them probably having ever before so vividly understood how completely this alpine paradise realised the ideal of it conjured up in their minds by Moore's poetical allusions in "Lalla Rookh." Their gratitude was also due to Mr. Millais for his illustrations of Mr. Lawrence's attractive paper—illustrations which went far to show that after all, in exceptional hands, photography could be art. But he desired to confine his comments on the paper to its record of what Mr. Lawrence had done for the development of the reproductive resources of Kashmir. He had been, at the India Office, the agent through whom, under Mr. Lawrence's direction, the vineyards of Kashmir had in recent years been replanted with American stocks, and the first consignment of the mulberry silk of Kashmir had this year been sold in London. It was found to be far superior in every way to Bengal silk, and had been sold for prices but a little below those of the best Italian silk. If a few obvious improvements were introduced in the reeling, there was a certainty of Kashmir silk competing, before many more years were past, on equal terms with the best Italian silk in the markets of Europe. It was an auspicious coincidence that at the very time Mr. Lawrence's consignment of Kashmir silk was being sold in London, Mr. Thomas Wardle, who he hoped, would address the meeting before its close, had been examining some samples of Cyprus silk sent him by the Secretary of State for the Colonies, and had found it to be stronger than any other known mulberry silk. There was, therefore, every prospect, if the economic development of Kashmir were pushed as energetically as Mr. Chamberlain was sure to push that of Cyprus, that before the close of another generation all the raw silk required by the silk manufacturers of Europe would be produced of the highest qualities, and on the most advantageous terms, within the red line of the British Empire, "the limits of Victoria." Mr. Lawrence said that silk was an ancient industry of Kashmir. If we are to understand *tussur* silk this is probably true, but not if mulberry silk i meant. This widespread and persistent error is due as he had before shown, to the inclusion, by som writers on this subject, of Northern India, or at leas Central Asia, within the bounds of ancient Serica and, again, to their identification of Northern Indi with Serinda. If you count one classical writer a good an authority on a geographical point as anothe you may argue that Serica is an indefinite term, an may vaguely be extended beyond Northern China through Mongolia, and along North-Western India to Turkestan. But the authority of Ptolemy, an after Ptolemy of Pliny, outweighs that of all othe Greek and Latin writers on the point, and Ptolem states that Serica is bounded on the east by th Sinæ, on the south by India, *i.e.*, Further India, o the west by Scythia trans Imaum, *i.e.*, Turkestan and on the north by an unknown region, *i.e.* Mongolia; and Pliny extends its eastern border to the Yellow Sea, "Oceanus Sericus." Un questionably by Serica Ptolemy meant, exclu sively, North-Western China—China north of th Yang-tse-Kiang; and Pliny, the whole of China The Chinese name for the silkworm is *s* in Corean *soi*, which is the Greek *σήρ*, th silkworm of Pausanias, and the French *soie*, th German *seide*, and the English "silk;" and thi etymology of itself defines the ancient Σηρική, o Serica, and all but limits the sources of the sil supply of the Greeks and Romans to China. Furthe the whole history of the extension of the culture c mulberry silk traces the aboriginal sources of it supply back to China. We have precise informatio of the introduction of sericiculture from China throug Corea, into Japan, and it was along the course of th Brahmaputra that it was gradually introduced int India, whence from Eastern Bengal, and Sikkim and Bhutan, it was carried step by step int Kashmir, Persia, Khotan, and Central Asia; an all this subsequently to the 6th century A.D Long before the time of Alexander the Great ra silk, probably *tussur* at first, had been imported int Greece, but Aristotle is the first who described th mulberry silkworm and its cocoon, and it was no until the time of the Emperor Justinian that its egg were introduced into Europe, and its systemati culture commenced at Constantinople. Thence i was carried into Asia Minor, and later, by th Saracens, into Sicily, whence it spread to Florence Venice, Naples, Genoa, and into the Valley of th Rhine, and even to Normandy. Now, during a these centuries, the only suggestion of any othe original source of the mulberry silkworm tha China, arises from the fact that the Arabic name fo silk is *dimaks*, the Greek *μέταξα*, and Englis "damask," and almost, certainly the Hebre *demeshek* of Amos iii., 12. It may be presume also to be the same word as the *meshi* of Ezekiel xvi. 10-13. The word can have nothing to do wit *si*, and whence did it originate? The Greek

m of the word, μέταξα, is first used by Pro-
pius, in the 6th century A.D., but the Hebrew
rds, *meshi* and *demeshek*, go back to the 6th and
h centuries, B.C., respectively. Are they variants
si formed in the course of the Arabian and Phœni-
an trade with Southern China (Sinæ) across the
dian Ocean, in the same way as Seres, *et cetera*,
re formed in the course of the ancient trade with
orthern China [Serica], through Scythia, Persia, and
nterior Asia? The Armenian for silk is *medax*,
viously one word with μέταξα, and this would seem
point to a Central Asian root for the word. But
e Armenians have from time immemorial been inter-
ediaries in the trade between China and the Persian
ulf, through the Indian Ocean, and may in this way
ve received the word from the Arabs. Procopius, in
is "Gothic War," iv., 17, tells us that about A.D. 530,
me monks came from India to the Emperor Justinian,
d offered to devise means by which the Romans
ould no longer be dependent for their raw silk on
e Persians [here Armenians] and, to this end, the
mperor arranged to give them a handsome reward,
they returned to India and brought back with them
Constantinople a supply of silkworms' eggs; which
ey did. This statement, of course, seems to bear
ut the supposition that mulberry silk was in ancient
mes produced in India for the Greek and Roman
arkets. But it really does not. The country which
he "monks from India" said produced mulberry
lk, they, in the passage referred to, distinctly
ifferentiate as Serinda. It was in Serinda they had
o long resided, from Serinda that they had come, and
o Serinda that they proposed to return, to procure
he silkworms' eggs for Constantinople. But this
erinda has nothing to do, as has been conjectured,
ith Sirhind in the Punjaub, or with Kashmir,
r any other part of India. It simply indicated
hina. Clemens Alexandrinus writes of σῆρας Ἰνδικούς,
"Indian silks," but means thereby, so far as mul-
erry silks are concerned, Chinese silks, imported
nto Alexandria by way of India. This route is
xplicitly described in the "Periplus of the Red
ea." The (mulberry) silk stuffs were brought from
hina (China), through Bactria, down the Indus, to
arygaza (Baroach), and from Barygaza were
hipped to Alexandria. Before Justinian intro-
luced the mulberry silkworm direct from China to
onstantinople, he tried to destroy the monopoly
he Persians [here the Armenians] had of the
verland trade in silk, by stimulating the
rabian trade with India in it; but he
ailed, because the Persians (*i.e.*, Armenians), in a
arge measure, commanded the seaborne as well as
he overland commerce in this, at that time, ex-
remely precious stuff. A Latin writer, Servius, of
he 5th century, A.D., speaks of both the "Indians
nd the Seres" reeling silk from cocoons found in
rees; but after all the evidence above cited, he (Sir
eorge Birdwood) presumed that the statement as
egards India is mistaken, that is if by "sericum"
e means not *tussur* silk, but mulberry silk. Serinda probably means "the silk (producing) India," *i.e.*, China. Anyhow it indicates simply China. He regretted the remark made by Mr. Lawrence in connection with the revival of the silk industry of Kashmir:—"A native with a microscope is a most uncertain combination." Everyone in India would understand the allusion, and he felt that it was most unjust. Any human combination with a microscope was always more or less uncertain; while, if any race of scientific students more than another was to be trusted with a microscope, it was the Hindus, on account of their extreme patience in observation and their remarkable tactile delicacy in minute manipulations. The immediate and the practical point, however, was that Kashmir, in spite of the defective organisation of the mulberry silk industry there, and of the diseases which afflict it, and almost obliterated it in 1876, can still produce mulberry silk of the finest staple and in unlimited quantity: while the demonstration of the capacity of the country in this connection we owe entirely to the intelligent initiative and persistent constancy of Mr. Lawrence; who for all his fruitful work in Kashmir, and for the fascinating paper with which he had favoured them deserved, and would receive, a double recognition of thanks and admiration from the brilliant audience of that evening.

Mr. THOMAS WARDLE (President of the Silk Association) said he had been honoured by a request from the Secretary of State for India to make an examination of the results of the large practical experiment of Mr. Lawrence in silk culture in Kashmir —between 2,000 lbs. and 3,000 lbs. of raw silk having been produced and sent to the India-office for examination—and he was very glad to report that the physical properties of the silk were not inferior to those of Italy, and those with a little better reeling from the cocoon it would in all respects be quite equal to it. He was quite sure there was a very great future indeed for Kashmir in silk producing; and he could thoroughly recommend young men of capital and enterprise to qualify themselves in sericiculture and go out to Kashmir and seek their fortunes. On the previous day, Mr. Geoffrey Millais had shown him several sketches he had made in Kashmir, which showed plainly how the mulberry tree abounded there; and Colonel Nisbet, who was there some years ago, and with whom he had corresponded at the time, informed him that the cocoons of the *Bombyx mori* were found in a wild state in sufficient quantities, that it paid the poor people to collect them, and even to pay a small royalty for the privilege. The question was now having the attention of the Kashmir State, and the Maharaja and Mr. Lawrence might be congratulated on the success they had already attained. He had brought with him samples of this silk in three qualities, which he would hand round for inspection, and he had also a piece of brocade made from Kashmir silk for the Stafford-house Exhibition, held in May, 1894, which had been shown to the Queen, who was greatly interested in it. As Sir George Birdwood had mentioned Cyprus, he might add that Mr. Chamberlain had done him the honour to ask him to examine a series of Cyprus cocoons which had lately been sent by the High Commissioner, Sir Walter Sendall, with the result that he had found the fibre stronger than any others he had ever examined, and that this silk for strength, tenacity, and thickness of ultimate fibre had not its equal in any part of the world. That of Kashmir, though not quite so strong, compared very favourably with it, and with that of France and Italy. With proper attention to reeling and security of contract there was no reason why sericiculture should not be so developed in Kashmir as to make us less dependent both upon China and Japan, as we should also be of Italy when the Cyprus silk industry became re-established. There was a very great future for both countries in this and other respects, and he thought the time would come, and before long, when English people would be wearing silk made in our own colonies and dependencies, in preference to that cultivated in other countries.

Sir Owen Tudor Burne, K.C.S.I., C.I.E., as Chairman of the Indian Committee of the Society of Arts, desired to express the acknowledgments of that Committee to Mr. Lawrence for his admirable paper, and he would also ask the meeting to thank the noble Chairman for coming to preside over these proceedings. The object of the Imperial Institute was to bring before the public of this country useful and practical information with regard to the history and products of those countries which formed part of the great empire to which they all belonged; and as one of the Governors of that Institute he wished to thank the Society of Arts—as this was the last of the series of papers to be read there—for coming to their help in spreading this information. He was glad to see a man like Mr. Lawrence "bubbling over" with enthusiasm in this prosaic age; but he might add that many present, including himself, who had been to Kashmir, were able to say that with all that enthusiasm, Mr. Lawrence had not exaggerated anything in his interesting address. He would advise everybody to leave the worries of London life, and visit that beautiful country, for he was sure they would never regret it.

Miscellaneous.

THE TRADE IN VANILLA.

In the number of the *Journal* for March 27th, see *ante* p. 453, some facts were given on the condition of the quinine market and an incidental
reference made to vanilla. In this connection it ill
probably be in the memory of many readers at
the history and botany of the plants furnishing is
useful product have recently been fully dealt wit in
the *Kew Bulletin*, and to the matter to be fo d
therein the following extracts from the same nur er
of the *Chemist and Druggist*, which contains ie
foregoing remarks on quinine, will be suppleme l,
and of value as completing the commercial le
of the question. In consequence of the h
price that vanilla always commands in the r-
ket, the crystalline principle has been imitated y
a substance generally known as vanillin.

"When this substance was first introduced a a
commercial article, now a good many years o,
the planters and others interested in the va la
trade were much scared at the new comp i-
tion, but events have shown that their fears e
unfounded, for although the use of vanillin y
have prevented the consumption of vanilla f n
assuming such large proportions as it would ot -
wise have done, it has not in the least proved n
obstacle to the profitable culture of the vanilla pl ;
and it is notorious that the employment of va a
has greatly increased of late years. It is also n -
worthy that vanillin is now lower in price tha t
has ever been, while fine vanilla realises hig r
figures than it has done for years. It seems, in f ,
that in many instances the commercial prepara n
of a synthetic product, after creating a tempo y
depression in the market of the natural drug wh h
it is intended to replace, finds a place side by e
with the sale of that product, and remain therea r
comparatively powerless to affect the commer l
position of the natural article. Cumarin and artifi l
musk are cases in point, in addition to vanillin.

"The future course of the vanilla market will
largely influenced by the receipts of Réunion (Bo-
bon) and Seychelles vanilla in the course of the n t
three months. When the first arrivals of the n
vanilla crop came to hand in October, the stocks l
fallen to a very low point everywhere; since th
there has been but little chance of accumulati ,
owing to the strong demand, but at present the b
of the crop is coming in, and it remains to be s
whether buyers will be able to absorb it with a rapid
approaching that with which it arrives. The princi
stock of vanilla in Europe is usually kept in Fran
especially at Paris and Bordeaux, where the bulk
the Bourbon crop is received in consignment, a
whence considerable quantities are habitually sent
London for sale. In September, just before the arri
of the new crop, a stock of from 15,000 to 20,000 kil
in Bordeaux, and as big a one in Paris and Marseil
combined, used to be a fair average, but during t
year the supplies in France did not by any mea
reach the lowest of these figures, while the Lond
stock was below rather than above its usual scan
figure of about 2,000 lb. The crops of vanilla
Réunion, Mauritius, and the Seychelles have been u
usually small, and it is said that the crop which is nc

nning to arrive will again be a very poor one, e reports of total failure have come from Mexico many weeks. As the United States require ı 130,000 to 150,000 lb. of vanilla every year, have been obliged for some time to purchase lla in Europe, and their orders have helped a little to increase the competition and advance market price of the drug. The American re- ements are probably larger than those of the of the world together, and we do not estimate total consumption of vanilla at much over 000 lb. a year, setting aside the Mexican pro- ion, and that from the smaller sources of supply. can count upon an average output of about 000 lb. a year in Réunion, and of about 00 lb. a year in Mauritius and Seychelles. With verage crop, therefore, the present production of lla is ample, and if the exceptionally high prices his year should lead to an extension of cultiva- , we may be confronted with a large over-pro- ion within a very few years. For, although lla is very sensitive of climatic influences, the t is easy of propagation, and yields a rapid rn, as the vines begin to bear in their fifth , and may continue to yield fruit until their eth.

Fortunately for those who sell the article, it ıs that comparatively few planters can grow it essfully. In Java, where vanilla was introduced 319, the culture was at one time of great import- , but at present the island scarcely counts as a lucer. In Mauritius also, vanilla-growing seems e dying out. The exports from that island fell 37,600 lb. in 1892 to 15,400 lb. in 1893, and o lb. in 1894. Réunion exported her first lla to Europe in 1849. That shipment was only ., but in 1870 the exports had grown to over 00 lb. Since then the largest Réunion crops been 190,000 lb. in 1891, 207,000 lb. in 1892, 175,000 lb. in 1893, but last year there was a t decrease. The production of Seychelles has exceedingly erratic lately. These islands first their produce to Europe in 1885. In the eeding years they quickly rose to an output of it 80,000 lb., but equally thickly dropped off n to about 17,500 lb. a year. According to the st reports, however, the output next year is y to show a great increase. The Seychelles and ritius vanilla is generally shorter, paler, and er in odour than that from Réunion, and realises r prices."

MARBLES, EARTHENWARE, AND MINERALS IN SPAIN.

pain contains many fine marble quarries, but she never made any serious efforts to bring them competition either at home or abroad with the ries of Italy, France, and Belgium. The best Spanish marbles are the white of Fuenteheridos, in the Province of Huelva; the coloured of Navalmoral, Santa Marta, Galicia, the Asturias, Almeria, Malaga, and Murcia; the greyish black of Jaca; the spotted of San Esteban de Castella; the yellow of Tortosa and Azpeitia; the whitish grey of Figueras; the azure of Gerona, and the blood red of Vizcaya. The United States Consul-General at Barcelona says that the industry of sawing marble is developing rapidly in Barcelona, Bilbao, and Malaga, owing to the duties imposed on the importation of similar materials from other countries. Barcelona, Valencia, Alicante, and Seville, are all producing large quantities of bricks and tiles, and are now able to meet more than the native demand for them. The mosaics and painted tiles for floors that are made in Barcelona, and which are in general use there, are excellent, not only as regards design but also durability. With reference to ceramics, delft, and porcelain, the various arts of producing useful and ornamental objects from earth are cultivated seriously and successfully in Spain. Some of the Spanish jars, vases, and plates are of exquisite workmanship, and are purchased in considerable numbers by Cubans and South Americans, as well as by the French. Much work is also done for the Germans, and after German designs. There are 87 glass and crystal manufactories in Spain, and they produce, not only enough for ordinary native use, but for exportation. Bottles for wines, liqueurs, and oils are turned out on a large scale in Barcelona, and demijohns innumerable proceed from the factories at Palma. Fancy glass and stained windows are also manufactured in and near Barcelona, and compare favourably, it is said, with the best work done in Italy and France. Looking-glasses are made in Saragossa, Valencia, Madrid, and Barcelona, but they are inferior to those produced in England, France, Germany, Austria, and the United States. Spain is exceedingly rich in minerals. In the north there is iron in Vizcaya, Santander, and Oviedo; pit coal in Oviedo, Leon, and Pavencia; zinc in Santander, Guipuzcoa, and Vizcaya; cobalt in Oviedo; and sulphate of soda in Burgos. In the centre there is quicksilver in Ciudad Real; pit coal in Cordoba; phosphorus in Caceres and Huelva; and salt and silver in Guadalajara. In the south there are lead mines in Murcia, Jaen, and Almeria; iron in Huelva and Seville; and sulphur in Murcia and Almeria.

COCOANUT CULTURE IN VENEZUELA.

Cocoanuts are indigenous to the sandy soil of the sea-coast, requiring the warm and equable temperature of the tropics. The coast belt of Venezuela possesses not only these, and every other requisite condition, but unusual facilities for the shipment of fruit to some central point. For hundreds of miles the coast presents a narrow flat surface, in many places extending some distance back; and the mountainous formation in other places is equally well adapted for the prolific production of the fruit. All the soap factories rely, to a great extent, upon their own groves for the oil from which they manufacture their product; but these groves are an insignificant patch, when compared with the waste and barren lands, unfit for any other agricultural purpose, and to be obtained at a very cheap rate. The Venezuela palm requires four years to attain the fruit-bearing period, after which time its producing power is enhanced year by year, until its full maturity is reached, about its eighth year; it then produces for 40 years. From 75 to 100 trees are planted to the acre, yielding fully 300 to 350 cocoanuts per annum. The profit of the small producer is not less than about 4s. per tree per annum. The large grower, handling and shipping his fruit, would, it is said, double that figure. The palm, while a tree of exquisite beauty, yields one of the most nutritious and useful fruits known; as an article of food, it is greatly relished; industrially, its principal use is in the manufacture of an excellent quality of soap, the cocoanut oil being preferred to fat because of its ability to absorb much more water than the latter. The husk of the fruit is now used as fuel; and on this point the United States Consul says it would seem that, in countries such as Venezuela, where carpets or other woollen or cotton floor coverings are discarded, and nothing but imported mattings used, the manufacture of the fibre of the husk into cocoa matting on the spot would prove profitable. Such an enterprise, aside from the possession of its own inherent excellence and elements of success, would probably receive great assistance and encouragement from the Government.

THE INDUSTRIES OF KIOTO.

As regards industries Kioto holds a most important place in the manufacture of embroidery, the production of porcelain, lacquer, and bronze goods, and objects of vertu in general. The Swiss Consul at Yokohama says that the finest and most beautiful textiles are manufactured in Nishinjin, a part of Kioto. All Japanese art fabrics, which in Kioto go by the name of "gobelino," are produced there, and perhaps the most striking of these are ladies' girdles. These broad girdles of silk, which are called "obi," are the pride of the Japanese women, and the magnificence of the obi is an indication of the position in society and the wealth of the wearer. An obi which is usually about twenty inches wide and ten feet long, may cost quite a considerable sum, even as much as 100 yen. Apart from the very expensive combs which are worn, the obi is perhaps the only article of personal adornment in which luxury is evident to the eye, but that there are other ways of dressing expensively is shown by the fabrics exhibited which serve as the linings for clothes. The material is perhaps a simple black on the outside, but it is furnished with a lining of rich, beautifully pr ted silk, costing a considerable sum a yard. Jap ese tapestry differs from European inasmuch as it represents rather the appearance of a flat surface, w ilst the tendency of European productions has been ore and more in the direction of producing the eff of actual paintings. The so-called *Yuzen-birido* cut velvets) is another remarkable product of m ern Kioto. In this branch of industry, the Jap ese manufacturer has attained a high degree of a tic perfection. The process of production is as foll s:—Before being placed in the hands of the artisa he velvet is prepared and dyed. It then has the de ns printed or painted on it, and the workmen cu he velvet along the edges of these. The other po on of the material is then cut away so that the pa rn alone stands out as velvet from the background. he effect is often magnificent. Kioto also pro ces cords and tassels for priests' robes, women's we ng apparel, &c. Silk threads of all colours, as w as gold threads for passementerie and weaving ar lso produced, as well as strings for Japanese musica instruments manufactured from raw silk. Silk c bes are also a speciality of Kioto, these being in ge ral use for ladies' dresses. The figuring on the is done by hand and is often very artistic, bo in the design and the arrangement. The embroid ies of Kioto are considered to be the finest and ost carefully executed of any in Japan, and are n-stantly being improved. The exhibits of the r-celain manufacturers of Kioto at the Jap se National Exhibition recently held in that city ere unusually striking and complete. The Kioto r-celain Company exhibited a splendid table servic or twelve persons, the cost being 200 yen. As reg ds the porcelain industry of the erstwhile Imperial ty of Kioto, it is of recent origin, and dates, it is id, from the present century. At first the porcelain as only coloured blue, but it has since been success lly coloured red and gold.

General Notes.

ROYAL INSTITUTION.—On Tuesday, April h, Professor James Sully will deliver the first a course of three lectures on "Child-Study and E u-cation;" on Thursday, April 16th, Professor D ar will begin a course of three lectures on "Re nt Chemical Progress;" and on Saturday, April 1 h, Professor W. B. Richmond, R.A., will give the st of a course of three lectures on "The Vault of e Sixtine Chapel." The Friday evening meetings ill be resumed on April 17th, when Professor G. Lippmann will deliver a discourse on "Colour Ph o-graphy."

AREA AND POPULATION OF JAPAN.—Accor g to a Japanese journal, although it is recorded in s-tory that the census of Japan was taken as earl as 281, no figures then obtained remain on record.

year 1720, the population numbered 26,065,422 ; 815, 25,622,000 ; in 1880, 35,929,000 ; in 1885, 69,000 ; and in 1893-94, although the exact es are not known, it may be inferred from the of increase during the preceding two decades the population of Japan at the end of the year could not have been much less than 42,000,000. Formosa has been newly added to the Japanese tory by the treaty of peace, and more than 0,000 of people in Formosa have, in consequence, me Japanese subjects, the present population of country is probably more than 45,000,000. The of the new territory being 2,532 square ri (sq. ri. 9 square miles), the total area of the country, ch was before the war 24,794 square ri, is now 26 square ri. Japan, in the extent of her terri- compared with European countries, stands next to Spain, being about equal to Sweden. is larger than Great Britain and Ireland by 3 square ri, and is the eleventh largest country in world. Her population is greater than that of nce by 6,600,000, but less than that of Germany 4,416,000. Compared with Great Britain and and, she has 7,100,000 more people. In popula-, therefore, Japan ranks as the fifth power in the ld.

RODUCTION OF CHROME ORE IN TURKEY.—ing industry in Turkey has hitherto been much lected, and it is only during the last few years t permission to sink shafts has been granted. s has led to a considerable increase in the output ores of all kinds. The *Montan und Metall ustrie Zeitung* says that this is especially the case h respect to chrome ore, which is worked on a e scale in the vilayet of Kossovo, where it exists considerable quantity, being chiefly exported to many and Great Britain, and in a less degree to stria Hungary, where it is treated especially at stiugg in Carinthia. Up to 1894 the chrome es were worked by the Ottoman Government hout firman—that is, without special authorisa- from the Porte; and the small quantity of ore ed, found a ready market. At the present time chances in favour of working chrome mines are roved, on account of the concessions granted by Turkish Government, which authorises the ex- tion without firman, of 200 ten ton waggon loads payment of a Government tax of nine Turkish nds, with an export duty of half a Turkish pound waggon (Turkish pound equals 18 shillings). en there is a firman the Government tax is uced one-half, and there is no limit to the quantity ch may be extracted. In 1895 Germany received n Turkey, through Hungary, more than 8,000 s of chrome ore.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

APRIL 15.—"Early English Organ Writers." By BURNHAM HORNER. Dr. E. H. TURPIN will preside.

APRIL 22.—"The Perfected Photochromoscope and its Colour Photographs." By F. E. IVES.

APRIL 29.—"Fruit Drying or Evaporation." By EDWARD W. BADGER.

MAY 6.—"High Explosives and Smokeless Powders." By HUDSON MAXIM.

MAY 13.—"Tunnelling by Compressed Air." By E. W. MOIR, M.Inst.C.E.

MAY 20.—"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock :—

APRIL 23.—"The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON.

MAY 14.—"Tea Planting in Darjeeling." By G. W. CHRISTISON.

The meetings of April 23, and May 14 will be held at the Society of Arts.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

The meeting announced for April 14th will not be held.

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

The meeting announced for April 21st will not be held, and Captain Pasfield Oliver's paper on "Madagascar," announced for that date, is unavoidably postponed, owing to the illness of the author.

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

PROF. HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.

LECTURE I.—APRIL 13.

(1). *The properties which make precious stones esteemed among minerals.*

Hardness, brilliancy, colour—The rarity of precious stones—Less known minerals which possess the required properties—Sphene, andalusite, axinite, idocrase, diopside, &c.—The hardness of minerals—Transparency, refraction, dispersion, internal reflexion—Why crystals are employed—The natural beauty of crystals—How it can be improved by art—The necessity of cutting—The nature of the opal, agate, turquoise—The colour of precious stones—Its variability—The chemical composition of precious stones—Absorption spectra—The absorption spectrum of almandine and jargoon—A relation between refractive power and weightiness—The garnet—The remarkable exception of diamond and sphene.

(2). *The properties by which precious stones are recognised.* — General properties : — (*a.*) Specific gravity—Hydrostatic weighing—The balance—The use of heavy liquids—Methylene iodide—Thallium silver nitrate.

LECTURE II.—APRIL 20.

(*b.*) Refractive power—Determination of the refractive index—The prism method—Its application to facetted stones—The total reflexion method—The reflectometer.

Properties peculiar to crystals :—(*c.*) Double refraction—Pleochroism—The dichroscope—The polariscope—Uniaxial and biaxial crystals—Positive and negative crystals—How to examine facetted stones. (*d.*) Cleavage—The cleavage of diamond and topaz. (*e.*) Pyro-electricity—How to observe the pyro-electricity of tourmaline—The identification of a rough topaz, and of a facetted tourmaline.

3. *The distinction of stones which may be confused* :—Garnet and ruby—Jacynth and cinnamon-stone—Zircon and lux sapphire—Garnet and olivine—Tourmaline and diopside, &c.—Artificial stones.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 13 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry A. Miers, "Precious Stones." (Lecture I.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Percy Griffith, "The Water Supply of Small Towns and Rural Districts."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. R. W. Sindall, "The Estimation of Moisture in Wood Pulp." 2. Mr. Watson Smith, "A Study of Comparative Affinities in the case of certain Salts of Ammonia." (Part II.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on "Mr. Hudson's paper, "The Conditions of Building Contracts."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. Theodore Wood, "Australian Mammals and the Theory of Evolution."

TUESDAY, APRIL 14...Royal Institution, Albemarle-street, W., 3 p.m. Professor James Sully, "Child Study and Education." (Lecture I)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W. 1. Mr. G. H. Hill, "The Thirlmere Works Water Supply of Manchester." 2. Mr. Deacon, "The Vyrnwy Works for the Supply of Liverpool."

Photographic, 12, Hanover-square, W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p

Colonial Institute, Whitehall-rooms, Whi place, S.W., 8 p.m. Mr. L. B. Clarence, Hundred Years of British Rule in Ceylon."

Asiatic, 22, Albemarle-street, W., 3 p.m.

WEDNESDAY, APRIL 15 ...... SOCIETY OF ARTS, street, Adelphi, W.C., 8 p.m. Mr. B Horner, "Early English Organ Writers."

Meteorological, 25, Great George-street, 7½ p.m. 1. Mr. William Ellis, "Mean of Cloud on each Day of the Year at the Observatory, Greenwich, on the Average Fifty Years 1841 to 1890." 2. Mr. E. D. Frid "Atmospheric Dust Observations from Parts of the World." 3. Major H. E. R "Analysis of the Greenwich Rainfall R from 1879 to 1890, with Special Refere the Declination of the Sun and Moon."

Geological, Burlington-house, W., 8 p.m. Beeby Thompson, "The Junction-beds Upper Lias and Inferior Oolite in Northa shire." 2. Mr. John H. Cooke, "Contribu the Stratigraphy and Palæontology of the *gerine*-limestones of the Maltese Islands." M. G. Crosfield and Miss E. G. Skeat, Geology of the neighbourhood of Caermar

Microscopical, 20, Hanover-square, W., 8 p.

Mining and Metallurgy, Geological M Jermyn-street, S.W., 8 p.m. Mr. P. R. I "Transmission of Power by Compressed Ai North Star Mine, Grass Valley, California.

Archæological Association, 32, Sackville-stre 8 p.m.

United Service Institute, Whitehall, 3 p.m.

THURSDAY, APRIL 16...Antiquaries, Burlington-house, p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Massee, "Berkeley's Types of Fungi re-desc 2. Mr. A. D. Michael, "The Internal Anat *Bdella, Latr.*"

Society for the Encouragement of Fine A Conduit-street, W., 8 p.m. Dr. R. A. D Lithgow, "Euphuism and the Euphuists."

Royal Institution, Albemarle-street, 3 p.m. Dewar, "Recent Chemical Progress." (Lect

Electrical Engineers, 25, Great George street, 8 p.m. Discussion on Mr. Dane Sinclair's "Telephone Exchanges, and Their Working

Historical, 20, Hanover-square, W., 8½ p.m. fessor Kuno Meyer, "The Early Relations Brython and the Gael."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, APRIL 17...Royal Institution, Albemarle-stree 8 p.m. Weekly Meeting, 9 p.m. Mr. Lippmann, "Colour Photography."

Civil Engineers, 25, Great George-street, S. p.m. (Students' Meeting.) Mr. Nichol Gedye, "Recent Developments in Light Engineering."

Junior Engineering, Westminster Palace S.W., 8 p.m. Mr. Walter J. Hunter, "Dred

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-s W.C., 8 p.m.

SATURDAY, APRIL 18...Royal Institution, Albemarle- W., 3 p.m. Professor W. B. Richmond, Vault of the Sixtine Chapel." (Lecture I.)

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FRIDAY, APRIL 17, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 13th inst., Professor ENRY A. MIERS, M.A., delivered the first cture of his course on "Precious Stones." The lectures will be published in the *Journal* uring the summer recess.

PRACTICAL EXAMINATION IN MUSIC.

The Practical Examinations in Vocal and nstrumental Music will be conducted by r. John Farmer, Balliol College, Oxford, nd Director of the Harrow Music School, xaminer, and Mr. Ernest Walker, M.A., us.Bac. Oxon, and Mr. Burnham Horner rgan), Assistant Examiners, at the House the Society, and will commence on onday, 22nd June.

Particulars can be obtained on application the Secretary.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the othergill prize of £25 and a silver medal for paper on "The Best Means of Effectually reventing the Leakage of Current to Earth in lectrical Installations from Generating Heat d Setting Buildings on Fire." The paper ould consist of about eight thousand words, d be written with a view to being read d discussed at an ordinary meeting of the ciety.

Papers submitted for the prize must be sent the Secretary on or before 1st of October, 96. Each paper must be typewritten, and ar a motto, the name of the writer being closed in a sealed envelope with a similar otto. The judges will be appointed by the ouncil.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges no essay deserving the full award is sent in.

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 15, 1896; Dr. E. H. TURPIN in the chair.

The following candidates were proposed for election as members of the Society:—

Bond, Hon. Robert, St. John's, Newfoundland.
Deadman, Henry Edward, Boscombe, Nightingale-lane, S.W.
De Bunsen, Moritz Ernest, British Legation, Bangkok, Siam.
Jacolette, Martin John, 40, Harrington-road, S.W.
Mott, Basil, 8, Queen Anne's-gate, S.W.
Simson, Alfred, 4, Fairlie-place, Calcutta.
Trollope, John Evelyn, 28, Craven-street, Strand, W.C.
Wilkins, Joseph Edwin, 5, Suffolk-street, Pall Mall, S.W.
Youlton, William, 159, Victoria-street, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Mackison, William, 8, Constitution-terrace, Dundee.
Manning, John Robert, Milkwood Estate-office, Herne-hill, S.E.

The paper read was—

EARLY ENGLISH ORGAN WRITERS.

By BURNHAM HORNER.

It is always pleasant and sometimes instructive to take a step backward in order to compare things as they were with things as they are. On looking over the former it is interesting to see the modes of expression and the workings of earlier times, whilst in the latter we are enabled to observe the influence for good, or the material for rejection, brought about by a past generation. In dealing with a subject like the present I do not wish to exceed limits of time, or try your patience by giving technical details of the organ. These are accessible to all in specific works. My object is rather to bring before you the results that have accrued from the powers of many minds in various decades; forwarded if not actually suggested, by mechanical means, placed, by ingenious organ builders, at the disposal of composer and executant.

The organ, in its primitive condition, consisted of a single row of pipes, and, by reason of its size, it was capable of being carried about by the hand, as may be verified by early paintings of St. Cecilia and other saints. The word "organ" has been employed in a loose and incautious manner to describe some music-making machines—thus fiddles, bag-pipes, the human voice—and the atrocity played by the mouth, have each been spoken of as an "organ." The word had, at least, two meanings, both restrictive and comprehensive. In its comprehensive sense it was mostly employed by writers of technical books, critics and burlesque makers; in its restricted signification it was applied to that wonderful combination of musical pipes with which most of us are familiar.

There was a time when poets, who, being guided by emotion rather than by reflection, have used the terms, "pealing organs," "ponderous thunders," and like expressions, having overshot the mark by stating, with a success, which is better in fiction than in truth, what could never have happened by reason of the immaturity of the instrument. But as no useful invention can exist without growth, the organ has, in accordance with that precept, developed to a very remarkable excellence in which pneumatics and electricity have superseded other mechanical aids to its manipulation.

Here, let me say that what is now an indispensable portion of an organ—a key-board which can be played by the feet—was a German invention in 1480. Of course, this appendage has been vastly improved, in range, compass and position, though it was not until the end of the last century that it was introduced, in its primitive state, into England. That in St. James's, Clerkenwell, had pedals in 1790, which simply pulled down the lower notes of the key-board, and added very little augmentation of sound to the general effect. The improvement of the pedals with independent pipes became a free agent, and can now act independently of the manuals, possessing qualities of its own which give as much pleasure to the hearer as satisfaction to the player. We can, in fact, scarcely imagine how the various changes of weather so graphically depicted in the Psalms were realised by "soulful" organists without the support which is now placed at the disposal of their feet!

An anecdote occurs to me at this poi
where an appreciative member of a congreg
tion was extolling the merits of an organ
who was given to represent "weather" effec
"My dear," said the lady over a cup of te
"you ought to hear our organist smite t
cattle with hailstones and the flocks with h
thunderbolts?" "Oh!" said her visit
"that is nothing! You should hear our's g
like a dog and run about through the city."

The history of organ music is divisible in
three periods. The first, commencing from t
earliest date in the history of the organ itse
continuously to the time of Henry Purce
might be compared in the form of its progre
to a crescendo sign, emanating from a po
and gradually increasing to a wide exte
when it stopped. The second period may, n
inaptly, be likened to a diminuendo sign,
it was at its greatest width towards the clo
of the 17th century, since it included Blow a
Handel and other great men at the beginnin
but thinned off with such writers as Nar
Jones, and Jackson. I must leave the su
gestion of a third sign for the third period
the imagination of my audience, for I c
think of nothing to compare it to—its peri
may be included within the present century.

The composers of the first period stand
the like relation to art as do the Horn bo
and Primer to literature. The lessons there
contained may be read with profit, need to
studied to ascertain the idioms of the age, a
they teach us to know how musical scien
was treated in its primary stages. I therefo
ask you to bear in mind that in no cases a
they intended to be considered as show piec
for the organ, but are simply and whol
brought forward as specimens of the style
the several periods of which I have spoke
One characteristic is what a non-music
person would term "want of repose" a
would consider "scaley."

This style is familiar to musicians as t
tonal period, and chiefly refers to the mov
ment of the bass. Our senses, in these time
are so accustomed to chromatic harmony a
sudden modulation that these old world soun
appear indefinite and deficient in grip. Th
"fathers in music" were seeking to emanc
pate themselves, however, from the thraldo
of the ecclesiastical scales to which they ha
served an apprenticeship, their modulatio
were simple and infrequent, whilst what wa
known as unequal temperament in tuning pr
vented the liberty of composing in more tha
let me say, about six keys. It was reserve

r J. S. Bach to write in 24 keys, which franhise took place between 1722 and 1744, and e also consolidated a sure and certain system f fingering in place of one which had been, itherto, chaotic and unsystematic in the xtreme.

Orlando Gibbons (1583-1625) was organist Charles I. His compositions show an arly departure from the style to which I have ferred. You would notice the activity of the ass against the slow chords in the upper arts, the monotony arising from limited odulation, and the style of melody which is mited in its compass. Here let me remark at at this period there were no pedals, neither id the organ, until 1712, possess the power of welling sounds or of controlling gradations of xpression. Later on, there were two rows of eys only on the largest organs, and contrasts f tone were only obtainable by variety of tops controlled by the hand and not by any echanical aid. The white keys at this time ere black, and the "sharps" white.

A greater than Gibbons now comes before s, Henry Purcell (1658-1695), organist of Vestminster Abbey. So recently as last ovember was celebrated the bicentenary of e death of Purcell, as many here may reember. Much enthusiasm was excited over e event, and great interest was manifested by e public in the works of our great master, ho died at the early age of 37, but not before e had done much for the benefit and instrucon of future ages.

Purcell did not contribute much to our organ tore, but there are a few solos reprinted in the ecently issued volume of the Purcell Society, nd edited by my old friend and master, Dr. J. Hopkins, of the Temple Church.

On the 9th of May, 1644, an ordinance was assed in the House of Lords to establish a ew form of divine worship, in which it was set rth that no music except metrical psalmody ould be allowed, and that no organs should e suffered to remain in churches; choir books ere to be destroyed; painted glass windows be broken by men hired for the purpose at 6d. a day; brass ornaments on the tombs be torn off: so that, in short, cathedral rvices were abolished. At Westminster, the ldiers were quartered in the Abbey church; e organs were taken down and smashed by en who cried out to the choristers, "Boyes, e have spoiled your trade; you must goe and ng 'Hot pudding pyes!'" At Winchester, natical people entered the cathedral with lours flying and drums beating; they rode up through the body of the church and choir until they came to the altar, "there they rudely plucked downe the table and brake the rayle, and afterwards carrying it to an alehouse, they set it on fire, and in that fire they burnt the books of Common Prayer, and all the singing books belonging to the quire: they threw down the organs, and broke the stories of the Old and New Testaments, curiously cut out in carved wood." So complete was the devastation, that more than half a century elapsed before churches began to be supplied with organs; organ builders being out of work, they had to exercise their hands in ordinary carpenters' and joiners' business. When a reaction came, the introduction of foreign organ builders became imperative, and to it we were indebted to such men as Father Smith and Renatus Harris, who erected instruments of very peculiar beauty of tone.

In the meantime, it may be readily understood, from the adverse circumstances related above, how musical productions, as well as mechanical execution, had lain dormant during the long period of unrest. Dr. Benjamin Rogers was the only representative of ecclesiastical art, and recourse had to be made to adaptations of foreign works to supply a need for a new order of things.

Charles II. countenanced a lighter and more airy style than had, in former times, prevailed. The Church service was restored, organs were rebuilt, and a fresh hearty enthusiasm in Church music took the place of shouting and yelling hymns and songs of a more or less blasphemous character. Then awoke a spirit of devotional singing, and the compositions of the Restoration evince a deeper feeling of genuine expression than do those of many other writers.

The organ itself was, early in the 18th century, very limited, both in compass and variety of resource. Two rows of keys were only occasionally met with, and three rows were of still greater rarity. There were very few which possessed pedals, and those only of a cumbrous and limited range. The touch of the player was sorely burdened by the heavy mechanism, and variety of colouring was restricted. For instruments such as these our organists had to write, and I would show that in consequence, monotony, scanty modulations, and restricted keys are some of the characteristics of the music of the period. Of fancy and expression there was little except that obtained by (as Sir Walter Parratt has recently put it) "half comic echoes on the swelling organ."

A family likeness pervades the music, and little individuality is manifest to help us in identifying any specific writer. It would appear that if any composer had anything to say it was necessary to speak to his hearers by the mouth of "Ten Voluntaries," "Six Concertos," or "Select Pieces."

The word "Voluntary" is a term used for an organ piece either before or after the Church service. In former years it also had a place after the Psalms of the day were read. As its name would seem to imply, the music was unpremeditated, but perhaps a more received notion is that it was something only left to the selection of the performer.

Judging from the many voluntaries handed down to us, they show many instances of decadence; and we have only tradition for a warrant that our bygone organists possessed marvellous powers of extemporisation. I, however, believe that in later times Thomas Adams and Purkis *were* exceptionally gifted in this respect, and I myself have heard the present Professor of Music in the University of Oxford extemporise a fugue in a very able and masterly style. It may be seen, on looking over early contributions to the common store, how miserably deficient they are in fancy—emanations of the brain without sympathy of the heart.

Imitation was substituted for invention—the flattery in almost every case being accorded to Handel, whose idioms and casts of thought became too common a property. In one respect it is very unfortunate that he came to England in 1711, for his influence became so enormous, and so unscrupulous were our native writers, that upon their own want of imagination they grafted *his* mannerisms to such an extent as to cloy and weary the listener. It may be that his over-stimulation would secure a ready sale for their works, or would confer a "hall-mark" upon a composition of really commonplace merit.

In our own day it must be observed how much Mendelssohn worship has influenced, in a like manner, our composers. I suppose it will be so until the end of time, but imitation very greatly retards progression and stultifies imagination. However, we see the effects of a master mind upon his day, and perhaps "it is better to rob the rich than the poor."

Other composers, such as Scarlatti and Geminiani, were at this period influencing men's minds. These composers were popular about 1730, and much credit redounds to Roseingrave, organist of St, George's, Hanover-square, by introducing the former to Englis men. After an interregnum Scarlatti is n appreciated by all ardent lovers of the go in art.

With that peculiarity of temperament whi characterised Dr. Burney, the musical hist rian, who could scarcely recognise any geni which was not of Italian origin, Roseingra (1960-1750) received condemnation for his u of extravagant modulation and for his freque employment of, what is technically known a Croft's chord—the minor 13th.

Regardless of Dr. Burney's opinions, mo advanced thinkers are disposed to underval his estimate, and to exalt Roseingrave to high position amongst gifted writers. Rosei grave's compositions are in some affinity wi those of Scarlatti, and may form a link betwe that writer and Sebastian Bach.

The keys chosen were those which mu have caused "the wolf" (caused by unequ temperament) to howl most unmercifull though possibly its presence is less promine by reason of the very thin and incomple chords Roseingrave has written. One thi is certain, that there is more fancy in this ear writer, more boldness of modulation, and mo freedom in the progressions than are t frequently observable in later writers.

There is, further, a solemnity present Roseingrave's music that appeals to those wh are sticklers for the fitness of things. There no "jigg" or "cornet" voluntary to gra upon the ears of a departing congregation, s that a regret may be indulged in that his mus has lain so long in abeyance.

The name of John Reading (1677-1764 should here be mentioned. He was organis of Dulwich College for about two years. H contributions to the organ were not many, bu Mr. Stocks, the present organist of the colleg informs me that a considerable quantity MSS. exists in his handwriting in the archive Reading is the reputed composer of "Adest Fideles." This is mere conjecture, as ther were three John Readings almost contem poraries.

Dr. Maurice Greene (1696-1755), organist St. Paul's Cathedral, was a prolific writer fo the organ. As a rule, Greene wrote in tw parts only, which, if played as printed, mus sound meagre and devoid of solidity. A feel ing comes over me that the object was t avoid harassing "the meanest capacity," a some text-books put it. The probability i that they were amplified by the Doctor himself and that the secret could only be conveyed to he aspiring performer by the medium of essons obtained from the composer direct.

Dr. Greene would appear to be one of the arliest writers of what are known as 'cornet" voluntaries. This stop, which is o more like the instrument known to us by his name than is a drum to a triangle. It omewhat resembles a modern "mixture," nd was used as a solo stop. The figures mployed in these solos were scale passages, hakes, and what may be termed inverted 'Alberti" basses in the treble portion of the eyboard.

The "trumpet" stop was much used by Greene as a solo register—the "calls" perhaps more suitable for Vauxhall Gardens than or awakening the slumbering echoes in the ofty dome of our fine cathedral.

The "echo" organ had not ceased to xist as a separate manual, although the 'swell" (1712) had just begun to dawn in ur midst.

Dr. Greene would appear to have possessed a ery hazy notion of the term fugue, seeing that fter the subjects are announced one does not ollow the subsequent working-out which is lemanded by this form—a proceeding by no neans uncommon in our own day by those vho imagine they possess the exceptional alent for extemporising. Whether consciously r not, Dr. Burney, with covert humour, termed his latter exhibition "prosing."

Thomas Kelway (1700-1767) affected the tyle of Scarlatti, and indulged in the arpeggio, r broken chord figures, peculiar to that writer.

Jacob Kirkman (1700-1776), one of the ounders of the present firm of pianoforte nakers, wrote much that is praiseworthy. His fugues, although now considered oldashioned in their treatment, are not beneath iotice, and although the part writing is not uch as could be recommended for the student o write out in four staves, yet the themes are resh and bright, added to which there is some magination in the slow movements.

John James (1704-1745) materially assisted Dr. Burney in "The History of Music," and vas honoured by a special notice in the Doctor's list of English organists. We can liscover nothing new in his work, and he only nultiplied mediocrity by fostering a vicious aste for rapid caperings upon the "flute" top.

Another writer was John Travers (1706-1758). Two double fugues are ingenious, showing a lecided advance in construction and working out. Modulation is more fully employed, and there is the introduction—in a tentative manner—of the "dominant pedal"—not pedal key be it noted—foreshadowing a rule enunciated by the strict school. One subject is curiously similar to one by S. Bach.

There were many organists in the last century who may have gained local notoriety as performers, but did not create any development for good in their compositions. They were stars in their day, but of very small magnitude.

History tells us nothing of them, and the following list is made in order to recognise their existence, though it may be unsatisfactory as regards actual dates.

Henry Heron has written ten voluntaries. He was organist of St. Magnus, London-bridge—the first organ that possessed a "swell" manual (1712). His treatment of the newly-discovered effects is thin by reason of the almost invariable two-part writing. There is, nevertheless, a seeking after effects that have not become common property. That old nuisance, the "vox humana" appears in this collection for the first time as a solo register. This organ possessed four manuals—an unusual complement in those days.

There were two composers named Goodwin of whom little is known. William Goodwin organist of St. Bartholomew's, Royal Exchange, published 12 voluntaries of the usual pattern, but there are fewer abrupt contrasts of tone colour in these than in most. The "rondo" form is largely employed in the final movements, and attempts are made at a device called a "stretto" in the fugues. In addition there is a foreshadowing of "phrasing," inasmuch as "staccato" is one of the terms employed.

Starling Goodwin, known as the composer of a once popular duet, "Could a Man be Secure," wrote 24 voluntaries by no means lacking in merit. They were "wrote for the improvement of juvenile performers," as the title page expresses—this use of the past tense being grammatical in the last century. The movements for the diapasons are ecclesiastical and devout in their style, but the rest are the usual "cornet" vulgarities. There is more taste, freedom, and imagination in these pieces than in many we have hitherto met with, and less of the time-honoured shake at the cadences.

To William Walond, Mus. Bac. (1757), organist at one of the Oxford colleges, we are indebted for 20 voluntaries and some others. The diapason movements are devout, the quicker ones the reverse. Some fugues, however, are good, as befits the work of a musical graduate.

Henry Burgess was harpsichord player at Drury-lane Theatre in 1744. He wrote six concertos, in which the Handelian form of divisions, cadences, and general style prevails. In the slow movements, the "scotch snap"—so called by Englishmen—is in great abundance. This latter is generally found in songs that are not Scotch at all.

Charles Avison (1710-1770), was a great lover of Marcello's music, and a pupil of Geminiani; he was a graceful writer, and probably an expert performer. We have, at some time or another, heard "Sound the Loud Timbrel." This melody appears in a collection of twelve concertos, Op. 9, and written in 1766. The compositions are chiefly in two parts, with a figured bass, regarding which a note occurs on page 3:—

> "N.B.—The accustomed performer on the organ or Harpsichord will easily fill up the the Harmonies of his part as directed by the Figures in Thorough Bass. It was therefore thought unnecessary to crowd the Page with a multiplicity of Notes, which only serve to embarrass the Melody."

The accompaniments for these concerti are two violins, one viola, and a violoncello, with a note to the effect that they may be reinforced at pleasure.

William Boyce's (1710-1779) contributions are ten posthumous voluntaries, in which there are suggestions of what are technically known as a "murky" bass. There is some ingenuity in the contrasted passages with scarcely any slavish imitation of Handel. The brief fugues are, it may be asserted, of good workmanship, the 9th and 10th being "tonal"—a species somewhat unusual among the "note stringers" of the period.

In addition to the post of organist of St. George's, Hanover-square, John Keeble (1711-1786) occupied a like position at Ranelagh Gardens. He published five sets of "select pieces," which, to quote the title-page, "although composed for the organ, are equally improving and entertaining on the harpsichord." From internal evidence he was a clever and ingenious contrapuntist, and his method of interweaving four or even five subjects with great skill may be accepted as a model for imitation. He probably had studied Bach, for by this time that master had received a hearing from the hands of James Hook, organist at Vauxhall Gardens, one of the first performers who endeavoured to make the grand works of this master popular. Canons are frequently employed by Keeble, and double counterpoint prevail There is here no lack of material, and th necessary knowledge to use it to advantag is remarkable. Such excellent work deserv and would pay for revival, if only as specimen of genius amongst so much that is unprofitab and arid.

A cotemporary of Keeble was John Stanle organist of the Temple Church (1713-1786 who composed sets of thirty voluntaries, s concerti, and perhaps many more. An ear use of printed fingering is that in Op. 5, an the "stopt diapason" is frequently indicat as "solo" register. Many of his passag are disfigured by being played on the corn and trumpet, while his skill in fugues cann be compared advantageously with that Keeble.

Rev. William Felton (1713-1769) followed the wake of other writers and produced concerti. The organ part is chiefly in tw part writing, and there are no figures to inc cate a fuller performance. There is, moreove "sincere flattery" in the entire set. A gavott infrequent save in the case of Handel, found in concerto 6, which brings the set to merry ending.

Dr. Alcock (1715-1806) wrote ten volu taries, in which the extraordinary combinati of stop diapason and flute on the choir orga is accompanied by sexquialtra and diapaso in the left hand. The only fugal movement the last, where the reply is a tonal one; other respects the construction is not skilfu The compositions are seldom in more tha two parts.

Dr. Nares (1715-1783) compiled the fir progressive series of lessons for the organ in work called "Il Principio," and six fugu with introductory voluntaries were compos about the year 1773. The latter are unintere ing to modern tastes, but the harmonies a fuller than those of the preceding compose The progressions, too, are not those accept in later times.

Dr. Burney's (1726-1814) "Six Corn Pieces," preceded by an introduction for th diapasons, and followed by a fugue, are of polite though not of a remarkable character.

Dr. Aylward (1730-1801) has not sufficient identified his six lessons for the organ with th character of the instrument to demand special notice.

Dr. Worgan (1724-1790) enjoyed an ama ing popularity as a performer at Vauxha Gardens. His compositions are numerou and some published after his death conta nstances of his seeking for new harmonies and effects. An organ concerto in D minor; ntroduction and fugue; and a voluntary in D, appear to be all the published organ compositions of the author. Dr. Worgan succeeded Gladwin as organist at Vauxhall Gardens.

The collection of pieces for the organ, Op. 8, by Dr. Dupuis (1733-1796) exhibit great varieties of style, and some breadth of treatment. The voluntaries are generally in three movements. There is another series of nine voluntaries for "juvenile organists."

Dr. Philip Hayes (1738-1797), while still a gentleman of her Majesty's Chapel Royal, composed "six concertos and a harpsichord sonata," with accompaniments. The "learned doctor" appears partial to "Alberti" basses, and the crossing of the right over the left hand s redolent of Scarlatti. The concerti are in three movements. There is an absence of modulation saving that to the dominant, and to the key a minor third below. The upper manual s frequently termed the "swelling" organ. It should be noticed that the rondo form prevails n the construction of the quicker movements, and the "air with variations" (affettuoso) inds a place in three of the set of six.

Thomas Carter (1735-1809) is the composer of a few elegant organ pieces, Op. 37. I have he first book only in my collection, and the pieces therein are exceedingly interesting. A ugal subject in the second voluntary is graceful in the extreme, while that in the third is of a vigorous character.

F. H. Barthélémon (1741-1808) wrote "Six voluntaries, or easy sonatas, for the organ, humbly dedicated to the lovers of that instrument," Op. 11. They are of a "rococo" nature. In the last short fugue, however, here is evidence of study and construction. Almost all the final cadences before the fugue t is announced are founded upon the Italian cadence.

James Hook (1746-1827) was an exceedingly busy man, and a notorious punster. He edited, conjointly with Dr. Callcott, four volumes of Handel's choruses, and composed a quantity of concerti and sonatas for the organ, all of which are now scarcely to be obtained. He was one of the first organists who strove, though unsuccessfully, to make Sebastian Bach's organ music popular in this country, but owing no doubt to the novelty of the music, he manager of Vauxhall Gardens bade him desist—a prohibition scarcely to be wondered at when the miserable instrument is taken into consideration! But the excellent motive deserves to be put on record. Bach's compositions came not a moment before they were required, but his influence was slow in altering the character of English organ music.

The only organ compositions which can be identified of John Stafford Smith (1746-1836) are those published in a set of ten voluntaries published by Longman and Broderip. There is some amount of freedom in their treatment, the modulations are unusual, and the fugal portions interesting. The first fugue is announced on the "full chair organ," and only in the coda is the great organ used. The cadence is disfigured by grammatical faults.

To C. F. Baumgarten (1754-1824) may be ascribed the first printed music with three staves, the Savoy Chapel organ having a pedal board if not pedal pipes. The pedal parts are independent ones, and written for an F pedal board. I incline to the opinion that the organ did not possess open pedal pipes, otherwise I fail to apprehend the reason for an almost invariable use of the pedal keys in octaves. The fugues are of great length, and of much merit, the good graces of Sebastian Bach apparently not being unknown to the composer. It is refreshing to note the great ability of this writer, and the commendable departure from the prevailing dreary monotony of his fellow writers, while one can see, from the nature of the work, that the organ is barely sufficient to give scope to his thoughts. In common with all musicians, the theme of *Non nobis Domine* has great attractions for him, the subject of which appears as the coda of fugue No. 5. Like an experienced fugue writer, he never loses grasp of his subjects, and treats them in accordance with contrapuntal and canonical directions. With a suitable re-arrangement of the pedal part, these compositions would be exceedingly effective at the present day.

John Beckwith (1759-1809) published, in 1780, six voluntaries for the organ, some of which are of merit. Two bassoon soli, accompanied by diapasons, appear for the first time; the melody is chiefly that of tenor compass, and very effective, and a leaning towards the chromatic system is suggested in some of the pieces.

Matthew Camidge (1764-1844), in dedicating six concerti to William Shield, at the same time says:—"The author in this work has endeavoured to imitate the particular style of music which has been so long admired, namely, that of Handel and Corelli; this acknowledgement will, he hopes secure him from the critics' censure." On looking over them, the player is fully convinced of the author's frankness, a proceeding which might have been followed with much truth by hosts of his contemporaries. His concerti have no orchestral accompaniments, they are less disfigured than are most compositions in this direction by meaningless divisions, while the subjects are by no means trifling. If the composer had possessed more faith in his own powers he would possibly have been able, by the courage of his own opinions, to have produced something original, and have dismissed from the hearer's mind the notion that he was listening to a *réchauffé* of other men's mannerisms. Camidge evidently enjoyed the luxury of a few pedal keys, though the use of them is limited to tonic and dominant.

A great man, Samuel Wesley (1766-1857), now demands special notice. He had an original genius, and by the help of another greater than he, much good work resulted. Of the reverence he entertained for Bach's music, it is not necessary here to refer, since most organists are aware of his undertakings in that direction in conjunction with Horn and Jacob. His fugal writing is masterly in the extreme, his figures are fresh, and his progressions are bold. I have in my possession many voluntaries, all of them containing points of interest and indications of strong mental power. There is one instance of a pedal in voluntary 10.

Of lesser value are the organ works of his brother Charles Wesley, who as "organ performer to the Prince Regent," found it policy to please his Royal patron's predilection for Handel's music by introducing into his own works airs by the Saxon composer. For example, in voluntary No. 2, "Thou shalt bring them in," on the "swelling hautboy," is introduced (by particular desire); and again in voluntary 3, "Then will I, Jehovah praise," a most haunting melody, does duty for the final movement. "Six Concertos," Op. 2, are also from his pen.

The organ works of Dr. Crotch (1775-1847), though clever in construction, are devoid of any attempt at originality. Both to the player and to the hearer there exists the assurance that everything is going on well, the rounded periods and well-stated subjects conducing to much peace of mind, while this placidity is never broken by rash modulation or untimely discords!

Two sets of twelve voluntaries by William Russell, organist of the Foundling Hospital (1777-1813) are ingenious and distinctly original. Some are written, it is true, in accordance to, but may be without any sympathy with the tastes of the time. There are many musica sentences in Russell's writing which were probably thought graceful at the period of their composition, but which now seem feeble and uninteresting. But on the other hand, there is muc boldness in some of the fugual subjects. I the second book, a pedal part is apportione to a third stave. The pedal part, however, i not entirely independent in its movement, an the nimbleness of the fingers is far in advanc of the agility of the toe and heel. Haydn an Mozart appear to have exercised some influence in forming Russell's style, and there i little or nothing of the Handel worship whic delayed the progress of former writers. Ther is cheerfulness without frivolity, and solidit minus heaviness—qualities which commen themselves to all tastes.

Thomas Adams (1785-1858) was one of th best extempore players known, and if thos effusions were as masterly as his printed fugue they must have been indeed imposing. H was a genius gifted with melody, and th power of using it to advantage. His reac ing was varied and cosmopolitan as h "Overture in C minor" testifies. The si fugues written about 1820, and his numerou organ pieces, are clever compositions with ur usual harmonies and modulations, while th conduct of the fugues, or rather those whic have reasonable pretensions to that title, musicianly and vigorous.

One of the first English treatises on orga playing is that compiled at the end of the la century by Jonas Blewett, Op. 4. The fir part is didactic and the latter practica There is some good advice, limited of cours to the modified state of the instrument i those days, regarding the combination the registers, which as composition peda were inventions of a future time, had be drawn by hand. Particulars are given every register—a special notice being give of Snetzler's new invention—the Dulcean No pedal board or pipes are mentioned, bu short notes are made of the various organis of the period, one especially favoured is a M Jarvis, "whose delicacy in using the sing stops beggars description; and his imagination appears to be boundless in resources c variety and taste." The second part of th treatise consists of examples intended to illustrate and apply the theory of the first. Th music is of no value, but sufficiently difficu to "choke off" the aspiring student, wh ould be daring enough to consider the olume of such a character that would lead im, by graduated steps, to the goal of his mbition. In fact, there is no appearance of ethod in the treatise, so that the scholar ould have to become a more than tolerable erformer upon a keyed instrument before he ould attain any good result from its perusal. few paragraphs are given regarding the giving out" and playing of psalm tunes. fter discountenancing the method, then opular, of "entirely straying from the melody y too many cantabiles and graces," the uthor errs in the very same direction in his lustrations. Nor is he more consistent with gard to the interlude, which, he submits, hould be "an animadversion upon the last ne of the last verse." A device, common nough in our day, is met with in voluntary 9, iz., naming the preparation of the registers for ach manual.

The fugues and voluntaries, in two books, dited by Diettenhofer, are lamentable per-ersions of Eberlin's compositions. Whole assages are eliminated, harmonies are hanged, and the subject of the very beau-ful fugue in D amplified by being played octaves. In one case the heading runs: with additions and alterations, but originally y J. E. Eberlin." A note at the end of the ollection may cause you to smile: "A merry cheerful movement should follow here in rder to finish the book, but, as there is no ore room for it, the player will be so kind s to add one of his own, which will constitute e last part of fugues and voluntaries."

Bearing in mind that Clementi presented a reat number of Eberlin's fugues in his Practical Harmony" without perversions additions, much blame must be accorded the publishers of this edition for allowing ch a one to be issued from the engraver's ands.

George Guest, organist at Wisbeach in 1789-331, has written many voluntaries. One t, Op. 3, numbers 16, and Op. 13 consists of fugues. They are mostly tinctured by the ste which was fashionable at the time, as e imitations of the Anglo-Scottish "snap" stify. Such directions as "take out the ll organ, take out the principal and umpet," refer to the old "shifting moveent," while many subterfuges for the absent edal bass can only pertain to the "inner onsciousness" of the author. I am of opinion at this method was merely a subtle device arrest the attention of the congregation upon a sultry summer's day as a counter irritant to prevailing somnolence!

Of a different style, and of better workmanship are "six fugues" by J. Jones, who is only to be identified through being a pupil of Dr. Crotch. The subscription list contains many loved and honoured names in the musical world of the first portion of this century. The præludium in every case is merely utilised for asserting the key, or for the purpose of "trying a few chords." The fugues are extremely clever, notably No. 2 in E flat, and would possibly meet with much favour if reprinted. Here is good counterpoint, much contrivance, and no little invention.

John Garth, of Durham, has written "six voluntaries" in the prevailing Italian style of which, by his adaptation of Marcello's psalms to English words, it may be presumed he was an admirer. They are chiefly in two parts, and uninteresting as compositions.

With mention of a set of "twelve pedals exercises for the organ" (1838) by John Whitaker, this paper is brought to a close. The exercises are for the G compass, and are interesting through being the first published in England for the English organ, the C compass being then not generally accepted as the most appropriate range. They are chiefly adapted for the use of alternate feet, the heel and toe being very exceptionally marked. In addition to this restricted use, the exercises are seldom independent, but are usually duplicated notes played by the left hand.

A brighter dawn was breaking, and unlike such a phenomenon, was not followed by lowering clouds. The work of love and truth which moved such men as Gauntlett, Hopkins, and many others, to further the re-arrangement of the pedal board, temperament, and other luxuries, need not here be dilated upon. Suffice it to say that their work has received ample acknowledgment in the gratitude of living organists, and has been the means of enlarging organ-playing so that it has become a comfort to the performer, and inexpressibly delightful to the listener.

Here I leave my subject—one, from an antiquarian point, deeply sympathetic to me, and, I hope, not entirely devoid of interest to my audience. I have endeavoured to point out how enormous was Handel's influence over our composers, warping their minds and limiting their progress. Is it not so, in a large measure, in the present day? Is not everyone trying his best to go beyond his power to imitate a colossal genius like Wagner?

Fortunately, there are some organ writers who strike out a line of their own, and there are some native composers who can measure their length with such foreign writers as Merkel, Widor, or Rheinberger.

It is unfortunate that the general public is, to a great extent, uninterested in organ music. We have the best performers in the world, and our instruments can compare very favourably with other countries. One reason may be that the organ is not an easily accessible instrument; the other, that it demands very great labour on the part of the performer; it is also an instrument that exercises nerve power, to a large extent. A pupil of mine was once practising by herself, the bellows being blown by a half-witted boy. Bellows-blowers used to be deficient in mind, but powerful in physical force, a thought I commend to psychologists! Well, this lady was much troubled over a hymn tune she was practising, and after much stumbling, a head popped round the corner, and the simple-minded boy said, "You do not seem to get on well with that toon, mum. Could you do it better, if I was to whistle it over to you fust?" The organ was promptly closed, and my pupil was resolved only to engage in the future someone less frivolous, more patient, and with less accuracy of ear.

With this I close, but before doing so, allow me to thank you for so patiently listening to me; and if you have been interested in taking a retrospective review, it will amply repay me for searching for material so long hidden in many an old volume.

Mr. Horner illustrated his paper with a selection of pieces played on a Mason and Hamlin Liszt American Organ kindly lent by Messrs. Metzler and Co.

DISCUSSION.

The CHAIRMAN said it would no doubt have been noticed how frequently in passing along Mr. Horner had pointed out the formalities and mannerisms of the old organ music, and probably these had not altogether disappeared even now, because in music there was a sort of conservatism. In organ music, however, there were certain special differences, and much of it was necessarily artificial; he used the word advisedly. He remembered Sir George Macfarren saying once that nothing gave him so much difficulty as composing organ music. There was a sort of coldness about it which made it extremely difficult to write, and it was often a process of intellectuality rather than of expression. Some years ago Mr. Gladstone, at a friend's house, taking up a beautifully modelled violin, said that
little instrument had taken more years in its develop
ment than the steam-engine, and there was a gre
deal of truth in the observation. He should like
point out that we had machines—musical machin
especially—which expressed our thoughts and obeye
our wills, and in all mechanical contrivanes there w
one primary distinction. The steam-engine mig
consist of multitudinous parts because the object w
to secure power and regularity, apart from the actu
hand of the inventor or user; but in a music
instrument the development was exactly in t
opposite direction. Simplicity was the very geni
of a musical instrument; consequently the violin ha
been stripped of its strings one after the other un
it was left with only four and a bow, and it becam
so simple that it was perfectly fitted to expre
every shade of feeling which might arise in t
mind of the performer. The organ not being
simple, composers for it took refuge in the intellect
ality of their instrument. The organ was original
one row of pipes, but when it left the player's li
and gradually became the gigantic expression
musical thought it now was, it lost its place in a sen
as a medium of direct expression, and its developme
proceeded in the direction of intellectual contr
puntal and fugual writing. The great effects cam
partly through an exercise of mind, proceeding to t
exercise of heartfelt thought and expression. S
John Stainer once said that a fugue on the organ w
a logical expression of thought; and there was mu
truth in that. As a grand fugue rolled along in
vast building one realised that through its intellect
ality there was an expression quite different from t
natural expression which came to one directly in t
tones of a violin. The reason the organ was
popular with the northern nations of Europe, was,
took it, because amongst them logical thought a
the study of philosophy and science prevailed
largely. Thus the instrument became as it were
great glory, inasmuch as it was the embodiment
the two great departments of mechanical art.
comparison had been made between the orchest
and the organ, the orchestra with its ma
performers being called "sun music," kindli
light, electricity, and life; whilst the sounds
the organ might be called moon music, whi
shone with a borrowed, pale, reflected kind
light. The very devotional character of the org
arose from the fact that its methods of expression d
not come directly from the performer's mind. Y
had here the minimum mental power, compared
the maximum in the orchestra, and consequently t
calmness of the organ was most acceptable in chur
music. Mr. Horner had referred to the imitati
music attempted in the various stops, and he mig
remark that what was called the old cathedral sty
of performance was comparatively a modern inve
tion. The old players, dealing with a very imperfe
instrument, did not confine their manifestations
skill to the smooth steady style of playing, which ha
been called the cathedral style, which was most appr

ate in church music. The imitative style had vays been in use. Bach's music, as he rendered it, ording to tradition, was most interesting; the rasing was said to have been very marked. He ed his hands from the keys, one author told them, if he sought to play the building as well as the gan. He gloried in creating echoes, and in making music ring through the place, so that the smooth le was not so prevalent as people sometimes agined, though it was quite true that the *legato* s the glory of the organ. It was a very serious ng for English organists that the introduction pedals came so late; but, he might remark, t in one of Handel's concertos there was a arate pedal part. The word "voluntary," was culiar, and Mr. Hopkins told them it was st used by a preacher in a church within a mile that place, in the year 1690. Charles Avison s evidently a very talented man, and he had been rified, if not immortalised, by Browning. Dr. yce was at one time organist of a church in ames-street, but he held several other appoint- nts, and there was an entry in the parish register the effect that the churchwardens complained of non-attendance, with a warning to him that if he l not send better deputies he would soon be turned t of office. His salary, according to the parish oks, was £20 per annum. The overture in C minor, Thomas Adams, which had been mentioned by . Horner, was a very interesting piece, and was quently played by Sir Walter Parratt, even to this , especially when opening a new organ.

Mr. T. FORBES said the paper was deeply interest- to all lovers of the organ. As allusion had n made to "cornet pieces," it might be interest- to mention that at Huddersfield Parish Church, ere Mr. Parratt, the father of Sir Walter, was anist, there existed until it was rebuilt, a nounted cornet" which was a range of mixture ps displayed at the top of the case; he did not w whether Mr. Parratt ever used it, but he heard n his eldest son, Mr. Henry Lister Parratt, that it kept as a curiosity. The admiration of the whole the Parratt family for Thomas Adams was of y old standing, for Adams opened the organ at Paul's, Huddersfield, which was the first district rch there, the organ having been removed from Dunstan's, Fleet-street, when the new one by bson was put up. Adams was also the organist of St. orge's, Camberwell, where he (Mr. Forbes), once a boy, heard him play, and was much delighted. was an old custom to play a fugue or fugetta, ween each verse of the hymns, but the most curious t of the performance was the method of giving out hymn tune; it was not played as a simple tune t was written, but full of the most inappropriate lades, turns, and shakes. Mention had been made the position of Avison of Newcastle, at St. ncras New Church. The first organist there, for ut 50 years, was Henshaw, brother of Dr. Henshaw, of Durham Cathedral, and he (Mr. Forbes) once heard him play "Sound the loud timbrel" as a middle voluntary. Amongst the illustrious roll of organists, Mr. Horner had not mentioned John Bennett; he had only seen one or two of his compositions, but one of them was so good that he felt sure he was a very great organist. He was organist at St. Dionis Backchurch, Fenchurch-street, and amongst the subscribers to a set of voluntaries, in which there was a beautiful little diapason piece in D Minor, was Handel and many other names of repute. He should like to hear more about him, for he was sorry to say his information was but scanty.

Mr. A. DOLMETSCH said the reader of the paper had dealt very fully with the organ music by English composers of the 18th century, but there were many English composers before that time, and some of the music was good and better than any written in the 18th century. He might also remark that the florid music of Purcell, although exceedingly well played by Mr. Horner, was heard to great disadvantage upon so unsympathetic an instrument as the one employed. The organs of Purcell's time had a very clear, light tone, and on one of them the little runs and shakes which sounded heavy and clumsy to-night would have had a very different effect.

Mr. W. H. STOCKS (Dulwich College) said he had a "mounted cornet" on his organ, and would not do away with it on any account, if only for the sake of antiquarian considerations; but it was also extremely useful when he had to play old music. Some little time ago Dr. Hopkins said he wished he had the same thing at the Temple, but he had done away with it, and was sometimes in a difficulty in providing a substitute. The mounted cornet was not quite the same as a mixture: it was composed of a stopped diapason principal, 12th and 15th; but there was no break in it, as in an ordinary mixture.

Mr. HORNER said he should like to know how many ranks there were in the mounted cornet Mr. Forbes mentioned, for there was one in the Edinburgh University organ put up by Sir Herbert Oakeley, which contained 14. He did not know what the effect was, but the 64 feet pyramidon Sir Fred. Gore Ouseley invented, was not effective. He was much interested to hear about Adams being at Huddersfield. His knowledge of Bennett's music was limited to a series of organ fugues, which were edited by Dr. Westbrook some years ago, in which there were some by Bennett; but there were several Bennetts, and he was not sure that he distinguished one from the other. One other writer he had not mentioned was Battishill, but he acknowledged that his paper was very incomplete, and necessarily so, from want of time. He fully appreciated Mr. Dolmetsch's remarks as to the instrument, but he looked forward to the time when the Society of Arts could have one of their own. There were many beautiful old organ pieces which would sound delightful if transcribed for strings in four or five parts.

The CHAIRMAN proposed a vote of thanks to Mr. Horner, which was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

APRIL 22.—"The Perfected Photochromoscope and its Colour Photographs." By F. E. IVES.

APRIL 29.—" Fruit Drying or Evaporation." By EDWARD W. BADGER.

INDIAN SECTION.

Thursdays, at Half-past Four o'clock :—

APRIL 23.—" The Deserted City of Vijianagar." By CAPTAIN CHARLES ROLLESTON. SIR CHARLES ARTHUR TURNER, K.C.I.E.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock, unless otherwise notified :—

The meeting announced for April 21st will not be held, and Captain Pasfield Oliver's paper on "Madagascar," announced for that date, is unavoidably postponed, owing to the illness of the author.

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

PROF. HENRY A. MIERS, M.A., " Precious Stones." Two Lectures.

LECTURE II.—APRIL 20.

(*b.*) Refractive power—Determination of the refractive index—The prism method—Its application to facetted stones—The total reflexion method—The reflectometer.

Properties peculiar to crystals :—(*c.*) Double refraction—Pleochroism—The dichroscope—The polariscope—Uniaxial and biaxial crystals — Positive and negative crystals — How to examine facetted stones. (*d.*) Cleavage. (*e.*) Pyro-electricity.

3. *The distinction of stones which may be confused.*

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 20 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry A. Miers, "Precious Stones." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. Halsey R. Ricardo and Christopher Whall, "The Architect's use of Colour."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p. Paper by Prof. Cleland.

TUESDAY, APRIL 21...Royal Institution, Albemarle - stre W., 3 p.m. Professor James Sully, " Child Stu and Education." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p. 1. Mr. G. H. Hill, "Thirlmere Works for Wat Supply of Manchester." 2. Mr. G. F. Deac " Vyrnwy Works for Water Supply of Liverpoo

Statistical, Royal United Service Institution, Whi hall, S.W., 5 p.m. Prof. G. Udny Yule, "No on the History of Pauperism in England and Wa from 1850, treated by the Method of Frequen Curves ; with an Introduction on the Method."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. M T. Bolas, " Photo-Mechanical Notes of Histori Interest."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. M W. E. de Winton, " A Collection of Mamm from Ecuador." 2. Mr. F. E. Beddard, "No upon the Anatomy of a Grebe (*Æchmophor major*), with remarks upon the Classification some of the Schizognathous Birds." 3. Mes F. D. Godman and O. Salvin, " The Butterflies St. Vincent, Grenada, and adjoining Islands."

WEDNESDAY, APRIL 22 ...... SOCIETY OF ARTS, Jo street, Adelphi, W.C., 8 p.m. Mr. F. E. Iv " The Perfected Photochromoscope and its Col Photographs."

Royal Society of Literature, 20, Hanover-square, W 4½ p.m. Annual Meeting.

THURSDAY, APRIL 23...SOCIETY OF ARTS, John-stre Adelphi, W.C., 4½ p.m. (Indian Section.) Ca Charles Rolleston, " The Deserted City of Viji agar."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 2 p.m. Ar versary Meeting.

Chemical, Burlington-house, W., 8 p.m. 1. Pr W. N. Hartley, "The Temperature of Cert Flames." 2. Dr. Augustus E. Dixon, "Halog additive products of substituted Thiosinnamine 3. Messrs. C. F. Cross, E. J. Bevan, and Cla Smith, "The Constitution of the Cereal Cel loses." 4. Mr. W. M. Doherty, " An Appara for the Detection of Boric Acid." 5. Prof. Pur and Dr. S. Williamson, " Ethereal Salts of Op cally Active Malic and Lactic Acids."

Society for the Encouragement of Fine Arts, 8 p Conversazione at the Galleries of the Ro Society of British Artists, Suffolk-street, S.W.

Royal Institution, Albemarle-street, W., 3 p.m. P Dewar, "Recent Chemical Progress." (L ture II.)

Civil and Mechanical Engineers, 45, Charing-cr S.W., 7 p.m. Mr. A. Wollheim, " Flush Apparatus."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, APRIL 24...Royal Institution, Albemarle-street, W 8 p.m. Weekly Meeting, 9 p.m. Dr. G. Poore, " The Circulation of Organic Matter."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Burlington-house, W., 5 p.m. 1. R. Lehfeldt, " Symbolism in Thermodynamics." R. Appleyard, " Adjustment of the Kel Bridge." 3. J. Frith, "The Effect of Wave Fo on the Alternate Current Arc."

SATURDAY, APRIL 25...Botanic, Inner Circle, Regent's-pa N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p Professor W. B. Richmond, " The Vault of Sixtine Chapel." (Lecture II.)

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FRIDAY, APRIL 24, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. HENRY A. MIERS, M.A., delivered ie second and concluding lecture of his course n "Precious Stones," on Monday evening, oth instant.

On the motion of the CHAIRMAN (Mr. rancis Cobb), a vote of thanks was passed to ie lecturer.

The lectures will be published in the *Journal* uring the summer recess.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the othergill prize of £25 and a silver medal for paper on "The Best Means of Effectually reventing the Leakage of Current to Earth in lectrical Installations from Generating Heat nd Setting Buildings on Fire." The paper iould consist of about eight thousand words, nd be written with a view to being read nd discussed at an ordinary meeting of the ociety.

Papers submitted for the prize must be sent the Secretary on or before 1st of October, 396. Each paper must be typewritten, and ear a motto, the name of the writer being nclosed in a sealed envelope with a similar iotto. The judges will be appointed by the ouncil.

The Council reserve the right of withholding ie prize or of awarding a smaller prize or naller prizes, if in the opinion of the judges o essay deserving the full award is sent in.

roceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 22, 1896; LYONEL CLARK the chair.

The following candidates were proposed for election as members of the Society:—

Arundell, W. Arundell Tagg, Shillong, Assam.
Crawford, Henry Fawcett, Engineer's Office, Cavan, Ireland.
Hancock, Ernest Albert, Government Laboratory, St. Kitts, West Indies.
Learoyd, Samuel, Sherwood-house, Huddersfield.
Robertson, Surgeon-Major Sir George Scott, K.C.S.I., M.R.C.S., British Agency, Gilgit, Kashmir.
Ruttan, Henry Norlande, City Engineer, Winnipeg, Manitoba, Canada.
Saunders, Hon. Henry John, M.L.C., St. George's-terrace, Perth, Western Australia.
Spindler, Henry Lewis, Port Elizabeth, Cape Colony, South Africa.
Wood, William, Exton-house, 173, Choumert-road, S.E.

The following candidates were balloted for, and duly elected members of the Society:—

Henderson, George Thompson, 7, Billiter-square, E.C.
Macaulay, Frederic Julius, London and South-Western Railway, Waterloo Station, S.E.
Rhodes, John William, 7, Mitre-court-chambers, Fleet-street, E.C.

The paper read was—

THE PERFECTED PHOTOCHROMOSCOPE AND ITS COLOUR PHOTOGRAPHS.

By Frederic E. Ives.

For nearly fifty years the world has been hoping and looking for a direct process of photography in colours, and from time to time results have been obtained which led many people to think that the solution of this problem was near at hand. But in nearly every case it has been proved that the colours obtained were either unlike or not dependent upon the colour of the light rays which acted in their production, and it is an open question whether any real progress has been made towards realising a true and practical solution of the problem. Lippmann, by his interferential method, has certainly produced some very striking and even beautiful results; but in the course of several years only a few good examples have been produced by this method, in the hands of scientific experts, and nearly everybody has abandoned experiment with it in despair. The only practical success in the reproduction of colours through photography has been accomplished by an indirect process, which is best represented by the photochromoscope system, which I have been invited to demonstrate to you to-night.

The photochromoscope is an optical instrument, which by the aid of the photographic process, accomplishes for light and colour what the phonograph accomplishes for sound, and the kinetoscope for motion; but the necessary apparatus is comparatively simple and cheap, and the results are far more perfect. Based upon the trichromatic theory of vision, the photochromoscope system is a method of composite colour photography, by means of three uncoloured photographic images which constitute a colour record, and synthesis by optical superposition of the three images, each illuminated by its appropriate coloured light.

The first suggestion of such a method appears to have been made by James Clerk Maxwell, in a lecture delivered at the Royal Institution, London, May 17th, 1861. From the report of his lecture, which appeared in the proceedings of the Royal Institution, I quote as follows:—

> "Experiments on the prismatic spectrum, show that all the colours of the spectrum, and all the colours in nature, are equivalent to mixtures of three colours of the spectrum itself, namely, red, green (near the line E), and blue (near the line G).
>
> "The speaker assuming red, green, and blue, as primary colours, then exhibited them on a screen by means of three magic-lanterns, before which were three glass troughs containing respectively, sulphocyanide of iron, chloride of copper, and ammoniated copper.
>
> "A triangle was thus illuminated, so that the pure colours appeared at its angles, while the rest of the triangle contained the various mixtures of the colours, as in Young's triangle of colour.
>
> "The graduated intensity of the primary colours in different parts of the spectrum was exhibited by the coloured images, which when superposed on the screen, gave an artificial representation of the spectrum.
>
> "Three photographs of a coloured ribbon taken through the three coloured solutions respectively, were introduced into the lantern, giving images representing the red, the green, and the blue parts separately, as they would be seen by Young's three sets of nerves separately. When these were superposed, a coloured image was seen which, if the red and green images had been as fully photographed as the blue, would have been a truly-coloured image of the ribbon. By finding photographic materials more sensitive to the less refrangible rays, the representation of the colours of objects might be greatly improved."

In the course of the quarter century following Maxwell's lecture, means for producin colour-sensitive photographic plates were di covered, and such plates were employed i the manner suggested by Maxwell, althoug his lecture appears to have been entire forgotten, and the idea was for some yea credited to Frenchmen, Ducos du Hauron ar Charles Cros (1868), afterwards traced back Henry Collen, an Englishman, and Barc Ransonnet, an Austrian, whose suggestion appeared in 1865; and only traced back Maxwell 33 years after he delivered his lectu upon the subject at the Royal Institution.

There was a vital defect in all of the sug gestions which had been recorded up to 188 when I pointed out that, although pure colou must be used for synthesis, the colour filte through which the photographs are made mu bear such a relation to the colour-sensitiv ness of the photographic plates as will secur in negatives of the spectrum itself, densi curves corresponding to the distribution of th respective colour element in mixtures repro ducing the spectrum. In other words, tha while the colour filters for synthesis mu transmit only red, green, and blue-viol rays respectively, the colour filters for th photographic process must, collectivel transmit all of the visible spectrum rays, an each must bear such a relation to the characte of the sensitive plate as will secure photo graphic action corresponding to the respectiv colour-mixture curve. This might be said amount to the formulation of a new principl since, according to the report of Maxwell lecture, to which I have referred, his photo grahic negatives were made through the sam colour-filters that he placed in front of the la tern objectives in making the colour-mixtu experiments, as was also afterwards done b Du Hauron, Lippmann,* and others. Th theoretical and practical importance of th distinction which I have pointed out will b made clear by a sufficient examination in the science of the subject.

I shall be better able to show the nature an limitations of the means by which the repro duction of colour is accomplished in the photo chromoscope system, as well as the reason for such definite modifications of the origina procedure as I have already mentioned, I may be permitted to commence with a bri consideration of the relations of light and co our to the photographic process.

The wave motion, which constitutes a ray dinary *white* light is known to be very com- x, consisting not only of transverse vibra- ns in every plane, but of waves of thousands different lengths associated together, and ving forward so fast that many hundred llions of millions of each separate kind of con- tuent waves enter the eye in a single second· twithstanding this infinity of complex vibra- ns, we possess the means of separating the nstituents of such a ray of light, dividing into thousands of coloured rays by means of prism or interference grating, and splitting d twisting it in the most extraordinary man- r by means of the polariscope. It is only separating the ordinary ray of light into its nstituent parts, and exposing the sensitive te in the camera to each separate kind of ration, that we can arrive at a clear under- nding of the capabilities of the photographic ocess, for the kind and rate of vibration that oduces chemical change in some substances es not affect others, and the effect of one nstituent of a ray of light may under some cumstances be neutralised by the opposite ect of another constituent of the same ray.

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* *Photo Club de Paris*, March, 1892, p. 83.

Our first step in the analysis of a ray of ite light may be made by the aid of the ism. Of course we cannot, in practice, ndle a single ray of light, which is some- ing infinitely slender; but the constituents a bundle of rays, or a "pencil" of light, n be reflected, refracted, dispersed, split up, d twisted like a single ray. If we place in e slide-holder of the projection lantern a tal plate with a narrow slit in it, which uld show as a narrow line of light on the reen, a prism placed in front of the objective ll separate the different wave-lengths as we uld open a fan, changing the narrow line of ht into a broad ribbon of colours, varying in e from red, through orange, yellow, green, d blue to violet. It is thus proved, by this miliar illustration, that white light is a ixture of coloured rays.

We know that in white light most objects ow colour, and a single experiment shows e cause of most colours. If we place a red ass in the path of the rays, we shall see that is red because it absorbs, or destroys, nearly l of the rays except the red. It will help is experiment to project the coloured glass rectly upon another part of the screen, so at the colour of the glass and its analysis by e prism can be seen at the same time. The lass and the band in the spectrum are in this se of the same colour. Similarly, a green lass is green, because it transmits chiefly the green spectrum rays, and the colour of the glass and of the band in the spectrum is again the same. Most of the colours in nature are not so simple as these. Pink is a mixture of all of the spectrum rays except the green or yellow-green; and in this case the colour of the object is not like any part of its spectrum. Yellow is also a very impure colour, the most brilliant hues consisting of a mixture of all of the spectrum rays except blue and violet. It is really most remarkable that so many people should continue to regard yellow as a "primary" colour, when such a simple absorption experiment as this proves that the most brilliant yellow may be made up of nearly all of the green, yellow, orange, and red rays of the spectrum.

Although most of the colours in nature are due to specific absorption of some of the constituents of ordinary white light, many objects which ordinarily transmit all of the spectrum rays as freely as ordinary window-glass, show the most brilliant and beautiful colours conceivable when spread out in very thin films, as in the soap-bubble or in the polariscope, in which split rays are twisted or again divided and made to interfere with each other, so as to neutralise or suppress some wave-lengths, so giving rise to the well-known colours of polarised light.

Everybody here is of course perfectly familiar with these experiments; but there may be some interest in seeing them performed with a special lantern attachment which I have devised—an open front, carrying all of the optical attachments, and sliding smoothly to centering stops, so that we may have either ordinary slide projection, the spectrum, and a comparison patch, the polariscope, or the microscope, at a moment's notice.

The polarisation of a ray of light does not, under ordinary circumstances, affect its photographic action, and is of interest in this connection chiefly as a further illustration of the complex structure of the light ray, and a pretty example of the production of colours in the absence of specific absorption or prismatic dispersion.

Having analysed the ray of light, we are now in a position to intelligently consider its photographic action. Scientific men used to divide the spectrum into three parts, which were called heat, light, and actinism, although it was supposed that the heat rays blended with the light rays at the red end of the spectrum, and the actinic rays with the blue and violet at the other end. The old and long-standing reproach against monochrome photography, that it rendered dark colours, such as blue, in light monochrome, and light colours, such as yellow, in dark monochrome, was due to the fact that the ordinary photographic sensitive plates are, under the usual conditions of use, acted upon chiefly by the so-called actinic rays, while the eye is impressed chiefly by the more luminous rays towards the other end of the visible spectrum.

This defect in the photographic process has been overcome partly by increasing the colour-senitiveness of the photographic plates by treatment with certain dyes, and partly by the use of colour filters, which cut out some or all of the rays which are ordinarily too active. With some of the undyed extremely rapid dry plates, the use of suitable colour-filters alone is sufficient to secure correct rendering of colour values in monochrome; but, owing to their comparatively feeble colour-sensitiveness, it is necessary to give very long exposures. With the dyed plates, "orthochromatic" photographs can be secured with lighter colour filters and very much shorter exposures, though not as short as are ordinarily given in portrait and hand-camera work.

I exhibit a series of spectrum photographs showing the colour-sensitising action of certain dyes. These photographs were made a long time ago, on collodio-bromide emulsion plates, one used plain, and the others sensitised with erythrosine, cyanine, and chlorophyl. The ordinary plate is sensitive chiefly to the violet-blue, violet, and ultra-violet rays; the erythrosine sensitises for the yellow-green, and the cholorophyll for all parts of the visible spectrum except the extreme dark red. These photographs make it evident that all of the light rays have the property of actinism, that is, the power to produce chemical change. It will also be seen that, having dissected the ordinary light ray, we have also found the means for controlling the relative action of its constituents in the photographic process. Given a plate sensitive to all of the spectrum rays, we can stop the action of any not wanted by any interposing suitable colour filters, for the construction of which there is an endless variety of colours to be found in the coal-tar dyes and their combinations; and we can in some cases greatly facilitate the selection of suitable colour-filters, by using colour-sensitisers, which act only or principally in the part of the spectrum in which the chief action is desired. It follows that we can make photographs by the action of any group of visibl spectrum rays that we may select, and in an relative proportions that we may desire. Th adaptation of this means to the production photometrically accurate representations colour values in monochrome photographs very simple, it being only necessary to use combination of sensitive plates and colou filters which will (with quartz prisms and phot graphic lens) secure photographs of the spectru showing density curves like a graphic curv representing the relative visual intensity the different spectrum rays. A consideratio of the trichromatic nature of colour vision wi show how the same means, applied throug the production of three negatives instead one, is adapted to record and reproduce th colours themselves.

We have seen that the spectrum colour change as the wave-length of the light varies but we now come to a fact of the greatest im portance in its bearing upon the subject colour reproduction by photography. Colou does not depend upon wave-length onl Although the colours of the different parts the spectrum are fixed (depending upon th wave-length of the respective ray), it is sub stantially true that all of the colours of th spectrum, and therefore all the colours i nature, are, as Maxwell said, "equivalent t mixtures or three colours of the spectru itself."

The Young-Helmholtz theory of colou vision explains this fact by assuming that ther are three fundamental colour sensations— red, a green, and a blue-violet—which ma possibly be due to three kinds of nerves in th eye, and that all other colours are compoun sensations. Clerk-Maxwell assumed that th spectrum red, green, and blue-violet ray excited almost exclusively the respectiv fundamental colour-sensations, and that a other visible spectrum rays excited simu taneously two fundamental sensations. B means of his now celebrated "colour-box, he made measurements of spectrum colou mixtures, and plotted curves showing in wha proportions his so-called fundamentals combin to reproduce the other hues of the spectrum.

The photochromoscope system of colou photography is based upon, and is substant ally an application of these facts. Thre photographs of the object are made, becaus three colours are required to reproduce a others; and each photograph is made by th joint action, in due proportion, of the re spective fundamental colour, and all other hue nto which it must enter in the reproduction ; but each photograph is afterwards seen by ight of the fundamental colour only, and the hree are blended into one composite image. The application of the colour-mixture curves s most readily shown by assuming that we vish to reproduce the spectrum itself. We know that, in order to do so, we must mix the hree colours which Maxwell assumed to be he fundamentals, and that for each part of he spectrum we must mix them in the proporions indicated by the relative height of the espective colour-curves on the diagram in hat part. The lantern positives must disribute the respective fundamental colours upon the screen, in the proportions indicated by the colour-mixture curves. For instance, he positive for the red should be perfectly ransparent for that part of the spectrum where he curve of the red is highest, graduating off to practically complete opacity, on the ed side about Fraunhofer line, A, and on he green side at the line E. Similarly, he positives representing the distribution of the green and blue-violet elements should correspond to the second and third curves of he diagram. It is evident that three such mages, projected with red, green, and blue-iolet lights, would combine to form a corectly coloured and graduated representation f the spectrum upon the screen. Such posiives can be obtained by contact printing from egatives having a distribution of density orresponding to the colour-mixture curves, nd such negatives can be obtained by photoraphing the spectrum with colour-sensitive lates exposed through correctly - adjusted olour filters. A set of three negatives of any bject, if made with plates and colour filters dapted to secure such photographs of the pectrum (and correctly exposed and deeloped), will constitute a true and permanent olour-record of that object, a positive copy of hich record may at any time be translated nto accurate colour by triple lantern proection, but far more readily and perfectly in he photochromoscope, which I shall presently escribe.

It has been known for years that Maxwell's olour curves are not the true colour-sensation urves. The purest green of the spectrum is self a compound-sensation colour, and it is ot possible to excite the fundamental green ensation alone in the eye of a person who has ormal colour-vision. In the photochromoope system we are limited to the use of the ndamental red, the fundamental blue-violet, and a compound-sensation green for our reproduction colours. We have, therefore, no use for the true colour-sensation curves, which call for a fundamental green reproduction colour, which, to normal vision, does not exist ; we know it only as it is diluted with white, or red, or both, in the spectrum. The use of the sensation curves would, as I explained in a communication to the "Photographic Times Annual" (New York) for 1895, introduce a fatal defect in the process. We are concerned not with the mixtures of unrealisable fundamental sensations, but with the mixtures of actual spectrum colours, which must, however, be taken from those parts of the spectrum which excite most exclusively the respective fundamental sensations. Maxwell's curves represent the measurements of such mixtures, but with red and blue colours rather too far removed from the extreme ends of the visible spectrum to give the most accurate results which are possible. Maxwell's green cannot be much improved upon for this purpose ; for, although it does not excite exclusively the fundamental green sensation, the true sensation curves show that it excites that sensation relatively more than does any other hue of spectrum green. At F $\frac{1}{3}$ E, where the fundamental green sensation, according to Koenig's colour-sensation curves, is degraded by admixture of white only, the total degradation is about twice as great as at E. With Maxwell's green, we get the least possible amount of degradation of colour, and most of that confined to the darker portions of the spectrum, at the blue end ; with the green at F $\frac{1}{3}$ E, there is less degradation of green-blues, but more degradation altogether, and much of it in the moreluminous parts of the spectrum.

If we employ purer red and blue-violet colours in the lantern than those used in Maxwell's measurements, we must alter his curves slightly in order to obtain the most accurate results ; but neither in the photochromoscope nor in any other application of this principle for photographic colour reproduction has it been found practicable to employ much purer colours than Maxwell's "fundamentals ;" and as the measurements should be made with the colours actually employed for reproduction purposes, colour-filters proved according to Maxwell's curves yield results in which any degradation of colour is reduced almost to the practicable minimum. Nowhere is the deviation sufficient to be noticeable under ordinary circumstances, although special tests have shown that the curves may be slightly modified to advantage.

That all of the visible spectrum rays should act in producing the colour record, and that only the pure red, green, and violet-blue rays should be used in the synthesis, is clearly proved, and has now been recognised by authorities. The practical importance of observing these conditions, may be shown by considering what could be the effect of employing the pure colour-filters in making the negatives, or the colour curve filters for synthesis, in particular cases.

If we photograph the spectrum itself with colour-filters transmitting only red, green, and blue-violet rays, it is evident that the orange, yellow, and green-blue portions of the spectrum cannot act in producing the negatives, and will therefore be absent in the reproduction, which will consist of three widely separated bands of pure colour; it is necessary to use the colour-curve filters in order to permit action by the intermediate spectrum rays, and the subsequent blending of the pure colours, where necessary, to represent them in the reproduction. In the reproduction of very many of the ordinary compound colours in nature, negatives made with the pure colour-filters would introduce defects not less real if not always so obvious.

The use of the colour-curve filters for synthesis, would cause a pure red to be represented in the reproduction by a mixture of all of the spectrum rays between A and E, which might make either a yellow, an orange, or a scarlet, depending upon the relative red sentiveness of the plates for which the colour filter was proved. Pure green would be represented either as an apple-green, yellow-green, or yellow—it being possible to obtain correct negatives with filters of any one of these colours, on plates of one kind or another. Blue-violet would necessarily be very impure for similar reasons. In short, pure red, green, and blue-violet are colours which cannot be adequately represented by colour mixtures.

Some writers have advocated the use, for both photographic and synthetical purposes, of colour-filters, which are a compromise between the pure-colour and colour-curve filters, in order to simplify the practice of the method. Such a suggestion naturally appeals to slovenly operators, who care more for ease than for accuracy; but it will not favourably impress the scientific mind; and its adoption would evidently deprive the method of any value which it might have in application to scientific work, or even to high-class art repr duction.

Since the difference between colour-filte suitable for the negative process, and colou filters suitable for synthesis has been pointe out, it appears so obvious, that it is difficult believe that this difference was not recognise by Maxwell; but if it was, the report of h lecture was inadequate, since we do not fir in it any statement to that effect. It is qui possible that we may have here an example what is, in patent law phraseology, terme "insufficient publication."

Composite colour photography, so long as required the production of three separate neg tives, by separate exposures, and three sep rate positives, to be projected by a trip lantern, no matter how perfect the result could not be of much practical importance but I have contrived such simple and ine pensive apparatus as should, when purcha able, make the method practically availabl even to the amateur photographer. A came which is probably no more complicated than "kodak" makes the negative images whic constitute the colour record on a single sens tive plate, at one exposure; and a conta positive from this negative, when cut in thre and mounted on a folding cardboard fram can in a moment be dropped into anoth optical instrument, the photochromoscop which, as well as the camera, may be ma stereoscopic, and is even then not much larg than some of the ordinary hand stereoscope The colour record, or chromogram, whe viewed in this instrument, realises a repr duction which is so satisfying to the eye th the uninitiated imagine that it is the obje itself at which they are looking. It is far mo realistic than a mere colour photograph on flat surface would be, because the image free from surface reflections and distracti surroundings, and is in perfect stereoscop relief.

It is true that this is not exactly the kind colour photography that the world has be looking for. Although in practice, given t special apparatus to work with, the operati of the process is above criticism for ease a simplicity, and the result is perfectly sati fying to the eye, it is not what many peop have desired, because it does not produ fixed coloured images, which can be fram and hung upon the wall, or in a window, inserted in a book. Fixed colour prints ca be made from the photochromoscope neg tives, but only by so greatly complicating t

ocedure as to make it comparatively im-
acticable.

Ducos du Hauron was the first to produce
ılour-prints of this character, but his method
as not successful. The defects in his results
ere due to several causes, among which may
mentioned :—(1) A wrong theory of colour
lection; (2) the production of three nega-
res by successive exposures on separate and
fferent plates, by which means it is seldom
ssible to perfectly equalise exposure and
nsity; (3) the prints were made separately,
differently pigmented gelatine, by which
eans it is almost impossible ever to make
e three of corresponding gradation and
pth of colour, as is absolutely necessary in
der to obtain accurate results; (4) the prints
ere transferred to superpose them, an opera-
on which usually results in unequal expansion
d imperfect register.

I succeeded in eliminating these defects.
ly negatives were made according to the true
inciple, and at one exposure, on a single
nsitive plate. My prints were made by a
ngle exposure on a single sheet of bi-chro-
atised gelatine on a support of thin celluloid,
d were coloured, after cutting apart with
issors, by immersion in aqueous solutions of
itable dye-stuffs. This method of colouring
e prints has the very important advantage
at the colouring can be carried to exactly
e right depth by a little experiment; and an
er or under-coloured print can be made right
y re-immersion in the dye or in water. I
owed permanent colour-prints made in this
ay in Philadelphia in 1890, and here in 1894.*
he results are by no means equal to the
hotochromoscope image, and the method is
r too complicated and difficult to compete
ith the photochromoscope system for general
doption. The successful application of the
rinciple to the production of colour-prints by
achine printing involves still more serious
ifficulties and defects.

Who can doubt that the production of a
erfectly life-like representation, by a simple
nd easy process, even though requiring the
se of a special stereoscope to complete it, is
f vastly greater importance than the production of flat colour-prints by complicated, difficult, expensive, and yet comparatively imperfect methods?

The form of the photochromoscope suggests steps of stairs. It was first made with three steps, and on the top of each step was placed one image of the chromogram, which is made in sections hinged together, so as to fold up. The model was afterwards reduced in size, and made more powerful, by having only two steps, the third image standing upright against the front of the lower step. The red image, lying horizontally on the top step, is seen by reflection from the first surface of a transparent mirror of cyan-blue coloured glass, which stands underneath it and in front of the eye, inclined at an angle of 45°. The blue-violet image lies upon the second step and is seen (through the cyan-blue glass above-mentioned) by reflection from the first surface of a transparent mirror of green or yellow glass, which is also inclined at an angle of 45° under the image. The green image, standing upright against the lower step, is viewed directly through the cyan-blue and green (or yellow) transparent mirrors, both of which transmit the green light. By this means the three images are so blended as to appear as one to the eye. The use of coloured glass reflectors, which is my own invention, avoids double reflections, and consequent doubling of outlines, it being only necessary to use glasses the substance of which absorb light of the colour which they are intended to reflect from the first surface. It is possible to use instead a special thinly silvered mirror; but such silvered transparent mirrors will not bear rubbing to clean them, and can hardly be safely placed in a popular instrument, which must be cleaned at intervals and kept in order by ordinary purchasers. The photochromoscope with coloured glass reflectors can be cleaned and kept in order by a child.

The photochromoscope image must be seen to be appreciated. Scientific men who had admitted that the photochromoscope system should be competent to reproduce the colours of objects, assured me that they were, nevertheless, positively startled by the realism of the result. Thousands of people have now expressed their surprise and admiration, but this counts for very little in the minds of most of those who have yet to see it. It is so much a case of "seeing is believing," that it is a waste of time to discuss the subject with anybody who has not yet seen the results in the small table photochromoscope.

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* See *Journal of the Camera Club*, April, 1894, p. 60.
uite recently the Lumiere Brothers in France, and Dr.
elle in Germany, claimed to have made successful prints of
is character by methods of their own; the fact is, that they
ve adopted, without acknowledgement, my plan of making
coloured prints, and then colouring them by immersion in
ueous solutions ef the appropriate dye-stuffs, and that
hich is really new in their procedures neither simplifies the
ethod nor improves the results.

Even those who have seen and recognised the beauty and perfection of the photochromoscope reproductions often ask—and it is perfectly reasonable that they should ask—"What useful purposes will this invention serve?" This question always reminds me of the story of Faraday, who, when asked what was the use of a certain new discovery, retorted by asking "What is the use of a new-born baby?" I can, however, suggest a few important applications for the photochromoscope, artistic, industrial, and educational. In the first place, the works of the old masters can be reproduced by the instrument with every touch and tone of colour depicted as in the original masterpiece. The colour records, occupying little space, can be stored in a small cabinet, or readily sent from place to place for purposes of reference or exchange, affording to the artist opportunities to study at his leisure, and in the quiet of his own studio, the technique of the acknowledged masters of his profession, although the original paintings may not be accessible to him. Decorative work of all kinds can be as faithfully reproduced for the use and study of designers —tapestried hangings, mural paintings, stained glass windows, furniture, pottery, enamels, &c. Landscapes from all parts of the world and rare and valuable objects of scientific interest can also be included in the cabinet of colour records. It will even aid in medical diagnosis by acquainting the practitioner with the actual appearance of skin diseases, and their changes from day to day under various conditions which he has not met with in his own practice; I shall not be at all surprised if its value to the science and practice of medicine shall prove to be incomparably greater than that of the so-called "new photography" with the Röntgen rays. It will even prove of considerable value, especially in that country of great distances, America, to many commercial travellers, enabling them readily to show to their customers the exact appearance, in colour, of objects of merchandise which are too large or too valuable to be economically carried about as samples. It will also probably become an adjunct to every school and college in the world, not only as an illustration of applied science and a graphic demonstration of the principles of colour vision, but because it will afford, by means of colour records of rare natural history objects and peculiar cabinet specimens, a virtual extension of the school's collection which may add enormously to its educational value. Its application to portraiture is too obvious to call for comment.
Still other useful applications have alrea
been suggested, and new ones doubtless w
be, as it becomes better known.

The perfected photochromoscope came
consists of a casing which receives a da
slide at one end, and has a single achroma
lens of large diameter, in a sliding tube, at t
other. Behind the lens is a series of t
transparent and four silvered reflecto
arranged to divide each light ray into thr
so that three images are formed, identical
size and perspective, on different parts of t
7 by 5½ sensitive plate. This arrangeme
permits of a separate lens diaphragm for ea
image, so that after the colour filters are i
serted, the exposure for the different imag
can be perfectly equalised. This compar
tively simple instrument is made stereoscop
by means of an external mirror attachme
which is the invention of Mr. Theodore Brown,
Salisbury, and called the "stereoscopic tran
mitter." This attachment not only permits
securing three stereoscopic pairs of imag
with one lens, but at the same time revers
and transposes the images, which is necessa
in order to bring them right in the phot
chromoscope.

Any moderately skilful amateur phot
grapher, provided with this camera, should
able to make original chromograms with ve
little more trouble than is involved in the pr
duction of original lantern slides, For portra
work, a simpler camera can be provided, wi
three separate plates and larger diaphrag
apertures; but more skill and experience
necessary to operate the process successfull
when the images are exposed and develope
on separate plates. My aim has been to mak
the successful operation of the process a
nearly automatic as ordinary photography, an
the camera which I show accomplishes th
for all subjects not requiring short exposures

[The paper was illustrated by a series of lante
slides thrown on the screen, and the photochrom
scope itself was exhibited.]

DISCUSSION.

Mr. J. CADETT, being called upon by the Chai
man, said that the subject of three-colour photograph
was a very vast one, and he thought it would take to
long to discuss on the present occasion. When he fir
saw the photochromoscope he was intensely charme
with it, and there was no doubt the illusion was s
perfect that the observer really did not know whethe
he was looking at the object from which it had bee
taken or not. There were many questions arising i

nnection with chromophotography, both for pigent printing and in other directions, but it would ke so long to discuss them that he thought the idience would be better employed in examining the autiful results which had been attained.

The CHAIRMAN said, as there did not seem much clination for discussion, he would take the oppornity, while Mr. Ives was arranging the photoromoscopes on the tables, to move a vote of anks to him for his very interesting paper, and ose present would then have an opportunity of eing the photographs both in colour and relief. ost of them were accustomed to seeing stereoopic slides, but interesting and curious as the result as, he thought the effect on the mind always was at you were looking at a little clay model—whether were a basket of fruit or a statue, it was not the al thing. The total absence of all colour, the mere llow or brownish purple of the print, gave the fect of a model, though it was perfect in relief d detail. But in this case you saw the same odel endowed with the colours of nature, and then ceased to look like a model, and you ought you were looking at the real thing. Some Mr. Ives' slides which he had seen were the most alistic things in the world—you could not really ll whether you were looking at the real thing or an age of it.

The vote of thanks was then carried unanimously, d the members and visitors proceeded to inspect e slides in the photochromoscope.

Miscellaneous.

LONDON SCHOOL OF ECONOMICS.

The Summer Term of the London School of conomics and Political Science commenced on hursday, April 23rd, and will end on Wednesday, uly 8th. The following courses of lectures and asses have been arranged :—

Economics.—Public Lectures on "The Physioats." By Henry Higgs, LL.B.; "Continental abour Legislation." By Dr. Julius Mandello, of udapest. Special Classes.

Finance and Taxation.—Special Class. "The rinciples of Finance and Taxation." By J. E. C. unro, LL.D.

International Trade.—Special Class. "The Theory f International Trade in relation to the History f Commerce."

Statistics.—Special Classes.

Palæography and Diplomatics.—Special Classes. Palæography and Diplomatics," chiefly of English anuscripts and records from the twelfth to the venteenth century. By Hubert Hall, F.S.A.

Research Studentships.—Two Research Studentships will be awarded in July, 1896, one of the value of £100 for two years, presented to the school by the Hon. Bertrand Russell, M.A., Fellow of Trinity College, Cambridge; one of the value of £50 a year for two years, for women students only, presented by a lady interested in the promotion of economics and political science.

THE WORLD'S GOLD AND SILVER PRODUCTION.

A report has recently been issued in the United States dealing with the production of the precious metals in the chief countries in the world in 1895. The figures for the United States are obtained from direct returns made by the several refiners, and are stated to be very nearly exact. Those from Mexico are from the reports of the Mexican Mint. The Canadian statistics are in part from the official returns, and the same may be said of the Guiana figures. The Russian figures are from special official reports of the deposits in the Russian Mint during the year 1895, and are consequently virtually complete and accurate. South Africa returns are from official figures for eleven months of 1895, and a careful estimate of the remaining month. The United States has once more resumed the first place among the gold-producing countries of the world, the output of Australasia having increased less rapidly; Africa takes the second place, and Australasia is third, Russia retaining, as in 1894, the fourth place. The total output of gold in the United States has reached, approximately, £9,348,000, the increase being made up by gains in almost all the mining States. The silver production from United States ores was somewhat less than in 1894, but there was a considerable increase in silver smelted or refined from imported ores and bullion, the total increase being small. The estimated production of gold in Mexico for the calendar year 1895 was £1,167,000. With regard to British North America, there was great activity in mining and prospecting in British Columbia, both in gold and silver properties, the number of mines opened and actually worked being steadily on the increase. Several British Columbian properties have been vested in companies, which propose to work them on a large scale, and there has been a continued influx of men and capital from the United States. A large part of the product of the mines goes to the States, either in the form of ores sent to the smelters or of bullion to be refined. The output of Ontario shows but little change, but work has continued steadily in the gold mines of Nova Scotia, and the mining department of that province reported that the total output for 1895 was 22,500 ounces of gold. In South America no material change was shown. The production in British Guiana slightly increased over that of 1894, the total amount being valued at £524,300. In Brazil and Venezuela the output continues to be small, and in the silver mining of South America there was no new development of importance, Bolivia and Peru continuing their production, but only showing a moderate increase over the previous year. In Europe, no country outside Russia is a large gold producer. In the Russian Empire (including Siberia) the output of the precious metal in 1895 showed a notable increase, being estimated at £7,081,000, the increase of production, as compared with the previous year, being £1,470,000. The production of silver in Russia is not large; it varies slightly from year to year, but does not show any considerable increase. Turning to Australasia, the gold mines in 1895 continued the increase shown in the previous year, although not in quite the same ratio. The provisional figures of production—viz., £9,167,000—were surpassed by both the United States and South Africa, so Australasia has dropped from the first to the third rank. New Zealand, whose production had been declining for several years, in 1895 attracted a new interest. The development of several mines on a large scale has been begun, and capital for others has been received, so that increased production may be expected in 1896. In British India the Colar goldfield in Mysore continues to be the only one whose regular workings are in progress, and this field has shown a healthy growth, the output for 1895 having been 249,491 ounces, as against 163,140 ounces in 1892. With regard to China, the amount and source of gold production still continues to be a mere matter of discussion, and in Japan the gold and silver production is not large. Korea is known as a gold producer only through the fact that it exports gold in some quantity (£212,200 in 1893). In the Philippine Islands two English companies obtained, in 1894, concessions to work in the goldfields, and developments have been made which, it is stated, will warrant the expenditure of a considerable amount in machinery. With regard to Africa, the gold production of the entire Transvaal reached (estimating the month of December) a total of 2,530,000 ounces, of a value of £8,896,000. The cost of transportation is still so high, and the difficulties in the way of obtaining machinery are so great, that it has not been possible to begin working any of the numerous claims which have been taken up in Mashonaland and Matabeleland on a considerable scale.

WESTPHALIAN HAMS.

The peculiar and excellent qualities which has made Westphalian hams so famous are attributable, according to the United Stated Consul at Barmen, to three distinct elements, as follows:—(1) The hogs of Westphalia are chiefly bred for the express purpose of making the most tender meat and the least fat; (2) the manner of feeding and caring for the pigs is a speciality; and (3) preserving, curing, and, last of all, smoking the hams with *juniper* berries and branches is entitled to careful attention. The is a special predilection in Westphalia for the raisir of the so-called *Ravensberger Kreutzung* (Raven berg cross-breed). These are rather large anima with slender bodies, flat groins, straight snouts ar large heads. Another, but smaller species, is al raised in Westphalia, which is called *Koënigsberg Landschwein.* The principal component part swine food in Westphalia is potatoes, which a grown in large quantities. The potatoes are fir well cooked, and then with their skin mashed in th potato water. The pulp, thus obtained, is thorough mixed with wheat bran, or with rye, barley, or oa meal in a dry, raw condition. In pickling the ham they are first vigorously rubbed with saltpetre an then with salt. In order to prevent the spoiling the hams, as many cuts as can be prudently mac are made near the bone and strewn with saltpet and salt. The hams thus cured are pressed in pickle tun and entirely covered with cold salt ly According to their size hams remain in salt fro three to five weeks. After this they are taken ou of the pickle and hung upon a shady, but dry an airy place. The smoking is done in special lar chambers, the hams being hung up on the ceilin On the floor of the room a suitable quantity of saw dust, wood-shavings, and juniper branches is slowl charred. Besides juniper, beach and alder woo are used. The hams remain in the smoke two three weeks.

MANUFACTURE OF MATCHES IN BELGIUM.

A recent number of the Bulletin of the Labou Bureau of France states that the following ne regulations are in force in Belgium relative to th manufacture of matches. It is not sufficient in th future that the dipping plates of white phosphorou matches should be covered with hoods connectin with a strong draft chimney; a suction tube co nected with a mechanical ventilation must be esta lished on the level of the dipping plates and vesse which contain the paste. Respecting the com position of the pastes, they must not contain mo than 80 per cent. of white phosphorous witho counting the water; the least infringement of th regulation will not be tolerated, as it is satisfactori proved that an excellent match paste can be man factured from this consistency. The dryers, exce the tunnels in which workmen must remain, must future be aired by mechanical ventilators. Permane committees exist which are to fix the amount of ai The working tables upon which the white pho phorous matches are filled must likewise be ventilate so that the phosphorous vapours may be immediate drawn off to the lower part of the workshop an thrown out. The ventilation must be such tha combined with the other causes of removal of th r in the workshops, the expulsion of the air per our and per workman in each room where white hosphorous matches are handled, shall be at least 119 cubic feet. The removal of the air in the ooms where Swedish matches are handled must be 060 cubic feet per hour and per workman, and rther, each workman must always dispose at least 353 cubic feet of air. There shall exist in each ctory a room where vessels containing water and oap for the use of the workmen shall be placed. he strictest control will be exercised in this respect. Vorkmen will be subject to a preliminary medical amination, and afterwards to a monthly visit, the sults of which are to be duly inscribed in a record ook. They shall not be allowed to work from the me when they may have been attacked by phoshoric necrosis, or from the period when they appear be threatened with an attack of this disease.

CO-OPERATIVE CURING HOUSES IN DENMARK.

About half the pork and bacon exported to England om Denmark is cured by the co-operative curing ouses of the latter country. The British Vice-Consul Copenhagen, says in his last report that after the o-operative movement had developed so greatly in iry farming, it could be expected also to comprise e curing houses when circumstances would make it ofitable. The rearing of pigs has always been of eat importance in so pronounced a dairy country as enmark, as the dairies supply a vast quantity of food r pigs. The number of these animals reared, has late very considerably increased, owing to the ormous quantities of cheap Black Sea barley which s been imported into Denmark during the last few ars, and which has been used for fodder. In 1890 d 1891, the number of pigs exported rose to very gh figures, but in 1892, in February, the English arket was closed for Danish pigs, and though a rge number were exported to other countries, this as attended with great difficulties, and there remained large number for which no market could be found. his naturally induced the farmers to export their gs in carcases, and the co-operative curing houses, hich had already begun to be established in 1888, ere greatly increased, and at the end of 1894 there ere about eighteen larger and smaller establishments read over different parts of the country, the largest tablishment slaughtering about 40,000 pigs a year. he principal advantage of the co-operative system is e doing away with the middleman. This advantage course also exists with the co-operative curing ouses, and as a whole they are said to work well. or small cottagers it is of course of great importance get a good price for their pigs, whereby they are duced to rear them. Every shareholder, without gard to the number of pigs delivered, has but one te in the matters of the curing house. The co-operative curing houses are generally started in the following manner:—All the farmers and others who rear swine in a district, the radius of which if taken in a circle is about eight to twelve miles, unite together and raise the amount necessary for the plant and starting of the curing house, by signing sureties according to which they are responsible for the payment of a certain amount, answering to about 10 kroners (kroner = 1s. 1⅓d.), for each swine stipulated in the bond for the delivery of swine to which reference is made below. Very often all the farmers of one parish act as a whole, so that their obligation is limited to the amount raised in the parish. These bonds of security are then deposited in the bank in which the loan necessary for building the curing house is raised. The rules of the curing house generally stipulate that the said loan shall be paid off in the course of ten years, after which period the curing house is owned by the shareholders in proportion to the number of swine delivered. The obligation to be surety is very binding and generally lasts for a period of ten years and very detailed and strict regulations are given respecting the transfer of the obligation to others. The participants further bind themselves to deliver all the swine they rear to the curing house alone. This obligation to deliver swine, which is the basis of the curing house, is strictly enforced, and severe fines are imposed for swine sold to others. The shareholders are, as a rule, bound to deliver swine at the curing house or at the nearest railway station, whence they are taken to the curing house at the expense of the establishment. Settlement is made according to dead weight, the swine being divided into three different classes when slaughtered. Payment is generally made within eight days after delivery with the deduction of one kroner per 100 lbs. The amount thus retained is used for different purposes, *e.g.* to collect a reserve fund. At some of the curing houses three-fourths of the value of the swine are advanced on delivery according to the prices for live swine. The prices paid for the swine are fixed in the following manner. In every curing house there is a Quotation Committee, generally consisting of the manager, the chairman, and a shareholder. These committees fix on a proposal, which is then sent to the Central Quotation Committee at Horsens (Jutland) where the final quotation is fixed. At every curing house there is a shop for the sale of sausages, fat, &c., and as a rule these pay exceedingly well, and form a great part of the profit of the curing houses.

Correspondence.

TOBACCO INDUSTRY OF INDIA.

In the *Society of Arts Journal* for March 13th, in the discussion on Mr. Tripp's paper on "The Tobacco Industry of India and the Far East," I notice Mr. Seton-Karr says that "the tobacco grown in Bengal proper is wholly consumed by the native population. At least, I never remember to have seen or heard of a cigar of Bengal tobacco bought or smoked by an Englishman."

In 1880 or 1881, when I was in Delhi, the Rev. James Smith, missionary, offered me some tobacco and cigars to smoke from Pusa Tirhut. I tried a few pipes and cigars, but cannot say I relished them. If I remember rightly, Mr. Smith seemed quite satisfied with his bargain, and recommended the cigars and tobacco on the score of economy.

The tobacco was light-coloured, burnt too rapidly, gave the impression of smoking straw, and required slices of potato to keep it moist. It must, however, be remembered that in India all tobacco soon becomes dry, especially in the hot weather, and requires some way of keeping it moist, peeled potato chips probably being as convenient as any other method.

J. W. PARRY,
Late Executive Engineer
Indian State Railways.

The Jungle, Anerley,
April 15th, 1896.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

APRIL 29.—"Fruit Drying or Evaporation." By EDWARD W. BADGER.

MAY 6.—"High Explosives and Smokeless Powders." By HUDSON MAXIM.

MAY 13.—"Tunnelling by Compressed Air." By E. W. MOIR, M.Inst.C.E.

MAY 20.—"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

INDIAN SECTION.

The meeting of this Section will take place on Thursday, at Half-past Four o'clock:—

MAY 14.—"Tea Planting in Darjeeling." By G. W. CHRISTISON. THE RIGHT HON. SIR RICHARD TEMPLE, BART., G.C.S.I., C.I.E., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evening, at Eight o'clock, unless otherwise notified:—

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MAY 12.—"The Future of the Fine Art of Wood Engraving." By W. BISCOMBE GARDNER.

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

JAMES SWINBURNE, "Applied Elect
Chemistry." Four Lectures.

LECTURE I.—APRIL 27.—Introductory—Phe mena of Electrolysis.

MEETINGS FOR THE ENSUING WEE

MONDAY, APRIL 27 ... SOCIETY OF ARTS, John-str Adelphi, W.C., 8 p.m. (Cantor Lectures.) James Swinburne, "Applied Electro-Chemistr (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p Mr. R. F. Grantham, "Rivers Conservancy Pollution."

Geographical, University of London, Burlingt gardens, W., $8\frac{1}{2}$ p.m. 1. Mr. Hugh Cliff "Journeys in the Native Malay States." 2. J. S. Black, "A Journey round Siam."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m

Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

Camera Club, Charing-cross-road, W.C., $8\frac{1}{4}$ p Annual Conference.

TUESDAY, APRIL 28...Royal Institution, Albemarle-str W., 3 p.m. Professor James Sully, "Child St and Education." (Lecture III.)

Medical and Chirurgical, 20, Hanover-square, $8\frac{1}{2}$ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p

Photographic, 12, Hanover-square, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., $8\frac{1}{4}$ p Conference continued.

WEDNESDAY, APRIL 29 ... SOCIETY OF ARTS, Jo street, Adelphi, W.C., 8 p.m. Mr. Edward Badger, "Fruit Drying or Evaporation."

Geological, Burlington-house, W., 8 p.m.

Mechanical Engineers, 25, Great George-stre S.W., $7\frac{1}{2}$ p.m. 1. Inaugural Address by the Pr dent, Mr. E. Windsor Richards. 2. Discussion Mr. Patchell's paper, "Steam Superheating."

United Service Institute, Whitehall, S.W., $3\frac{1}{2}$ p Mr. B. Tower, "An Apparatus for Providing Steady Platform at Sea for Search Lights, &c."

East India Association, 3, Victoria-street, S. 3 p.m. Mr. J. B. Pennington, "The District Tinnevelly before and after its Conquest by British."

Zoological, 3, Hanover-square, W., 4 p.m. Ann Meeting.

Camera Club, Charing-cross-road, W.C., $8\frac{1}{4}$ p. Conference continued.

THURSDAY, APRIL 30...Royal, Burlington-house, W., $4\frac{1}{2}$ p

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Pr Dewar, "Recent Chemical Progress." (L ture III.)

Electrical Engineers, 25, Great George-street, S. 8 p.m. Mr. W. Langdon, "Railway Telegrap with Special Reference to Recent Improvement

Mechanical Engineers, 25, Great George-street, $7\frac{1}{2}$ p.m. 1. Mr. Samuel MacCarthy, "Steel Stea Pipes and Fittings, and Benardos Arc Welding connection therewith." 2. Professor T. Huds Bearne and Mr. Bryan Donkin, "Research Co mittee on the Value of the Steam-Jacket; Expe ment on a Locomotive Engine."

Camera Club, Charing-cross-road, W.C., $8\frac{1}{4}$ p. Conference continued.

FRIDAY, MAY 1...United Service Inst., Whitehall-yard, S. $3\frac{1}{2}$ p.m. Discussion on the Naval Prize Essay.

Royal Institution, Albermarle-street, W., 5 p. Annual Meeting, 9 p.m. Colonel H. Watki "Chronographs and their Applications to G Ballisties."

SATURDAY, MAY 2...Royal Institution, Albemarle-street, 3 p.m. Professor W. B. Richmond, "The Vault the Sixtine Chapel." (Lecture III.)

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FRIDAY, MAY 1, 1896.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEW VICE-PRESIDENT.

The Council, acting under the 84th Bye-law, y which provision is made for filling up acancies occurring in the Council, have lected Sir Frederick Abel, Bart., K.C.B., .C.L., F.R.S., a Vice-President of the ociety in the place of Lord Leighton, P.R.A., eceased.

CANTOR LECTURES.

On Monday evening, 27th inst., Mr. JAMES WINBURNE delivered the first lecture of his ourse on "Applied Electro-Chemistry."

The lectures will be published in the *Journal* uring the summer recess.

PRACTICAL EXAMINATION IN MUSIC.

The Practical Examinations in Vocal and strumental Music will be conducted by r. John Farmer, Balliol College, Oxford, d Director of the Harrow Music School, xaminer, and Mr. Ernest Walker, M.A., us.Bac. Oxon, and Mr. Burnham Horner rgan), Assistant Examiners, at the House the Society, and will commence on onday, 22nd June.

Particulars can be obtained on application the Secretary.

roceedings of the Society.

INDIAN SECTION.

Thursday Afternoon, April 23, 1896; SIR HARLES ARTHUR TURNER, K.C.I.E., in the air.

The paper read was—

THE DESERTED CITY OF VIJAYANAGAR.

By CAPTAIN CHARLES ROLLESTON.

Several years ago when quartered in Southern India, the General of the Bellary district, in which my regiment was stationed, nominated me to an appointment in the territories of a native prince, the Raja of Sundoor, whose dominions comprise a mountain region some thirty-six miles away. Bellary was noted as an unusually hot station even for the plains of India, so I was by no means sorry on arriving at my destination to find myself in a delightfully exhilarating climate, like that of a fresh English May, and surrounded by a charming scenery of hills and valleys where stretches of picturesque woodland alternated with plantations and gardens, amongst which were strewn here and there the palm-thatched villages of the Hindoo population. Not long after my arrival a party of English officers visited our small hill-station on their way to Hyderabad, about 200 miles distant, but their route lay through the dominions of another native prince, the Raja of Anagoondi, to whom they had a letter of introduction from a friend of theirs, an English political official. As none of the officers I have mentioned were acquainted with Hindustanee, they applied for an interpreter, and the commandant appointed me to accompany them in that capacity.

The expedition promised to be one of peculiar interest for the following reason. A short time previously a gentleman in the Indian Civil Service had informed me that on the banks of the Toongaboodra, a river which separates British territory from that of Anagoondi, there was a most remarkable deserted city composed in a great measure of palaces and temples, many of which could hardly be described as in ruins because, having been built of massive stone-work, they had suffered so little from the effect of time. The route which we were to traverse lay close to the outskirts of this city, known by the natives as Vijayanagar, and it was decided by our party that we should start so as to reach the place in one day's ride, that we should allow one clear day for exploration, and that we should cross the river the next morning for Anagoondi, the capital of the native state.

As in the case of many Indian cities the period of the foundation of the one we were about to visit is unknown, and its origin is lost in the fables of prehistoric antiquity. From the very earliest times it would appear to have been considered as a place of considerable sanctity, a conjecture which is borne out by the ruins still existing of shrines connected with a very ancient form of idolatry. In the 9th century, a Mohammedan merchant, named Soliman, having visited Southern India, left an account of his travels, which, in 1845, were translated from Arabic into French, by M. Reinard. In this work Soliman describes several kingdoms into which the Deccan was then divided, and amongst them one large territory, the ruler of which owned an immense army and whose subjects appear to have attained a relatively high state of civilisation, as the explorer mentions cotton stuffs having been manufactured of such exquisite delicacy that a robe of the material would pass through a signet ring. This kingdom, named Rohmey by Soliman, M. Reinard considers, and apparently with good reason, can be identified with what was afterwards known as the State of Vijayanagar, but the condition in which Soliman found it did not last. At some subsequent time it broke up into several principalities and remained so until the year 1336. At the above period two Hindoo brothers, Harihari and Bakka, founded a small independent state on the south bank of the river Toongaboodra, and they appropriated as their seat of government the ancient town which was first known as Vidayanagar or the "City of Learning," the name being changed afterwards to Vijayanagar or the "City of Victory," and it is from this epoch that the most authentic history commences. The two founders, said to have been the sons of a neighbouring petty raja, were in fact little more than military adventurers. They had borne arms in the political turmoils which then convulsed the Deccan. They rapidly extended their authority, and, in a manner similar to that which has often occurred before and since in India, built up on the ruins of the smaller neighbouring states a dominion which took its name from the capital.

At a time when kingdoms rose and fell, owing to the vicissitudes arising from a state of warfare which the princes of Hindostan incessantly waged against each other, freebooters and partisan leaders often constituted themselves monarchs and founded dynasties; so it is not wonderful that in this fashion Vijayanagar took its rise under the ægis of a couple of obscure Hindoo leaders, and the state, of which it became the capital, reduced to a condition of vassalage all the min principalities of Southern India. I may he mention that the title by which we hold t city of Madras is contained in a deed of g conveyed to us by one of the nominal rajas the above realm, whom we acknowledge rightful owner, though, at the time of signi the document, he was a fugitive from his o country. The dynasty, founded as abo described, lasted for about 230 years, tl Hindoo territory remaining independent und successive Vijayanagar princes, who evinc the greatest taste in the embellishment of t capital, the mere ruins of which now cover area of about ten square miles. Consolid tion of the empire having produced intern tranquility, a long era of prosperity ensue followed by a great influx and diffusion wealth. Magnificent palaces and temp sprang up, learning was encouraged, and, fact, the country represented the last gre Pagan power in the south of India to f before the Mohammedan invasion.

Much interest must attach to Vijayanag owing to the fact that for about two centur it was the centre-point of purely native cultu when Hindoo learning and civilisation, u alloyed by foreign influence, reached a stan ard perhaps higher than they had ev attained in any other part of India. As t metropolis also of a state, wealthy, powerf and enjoying the advantage of an excelle administration, it contained an amount wealth so colossal as to be incredible, we it not that native historians are fully corrob rated by the accounts of independent Europe travellers. Of the above, I may mentio amongst others, Nicola Conti, an Itali Duarte Barbose, a Portuguese, and Cæs Frederick, a Venetian, all of whom have l records of their sojourn in Vijayanagar. Ab the middle of the 15th century the great Sou Indian State was also visited by a Persi ambassador, named Abd-er-Razzak, fr whose graphic account, combined with statements of other travellers, it would app that the fertile land was highly cultivated an industrious people; that the empire general was thickly populated, prospero and politically powerful. Evidence for above is afforded by the fact that the ru of the country was able to put into the field million of armed men, of whom 40,000 w cavalry, besides a force of 400 war elephan while in the capital alone there was a garris of 90,000 soldiers. Vartham, also an Itali visitor in 1503, speaks in raptures of Vinagar as a most attractive place of resi-ence. He says the site was beautiful, with cturesque surroundings; the climate was elicious; the land was rich; there was a rge trade; and altogether he describes the lace as a second paradise. Thus, from the cords of contemporary writers many interest-g particulars may be culled regarding an siatic civilisation which had developed rough Hindoo genius alone; and also as the manners, customs, and social life of a eople who represented at that period the ost advanced and cultured state in the dian land.

At the time of Abd-er-Razzak's visit the igning monarch was a raja, named Deva aya, who is described as very young, of a are body, rather tall, and of an olive colour. he palace was a handsome structure, cover-g a large area, as may be judged from the ct that the youthful monarch had an estab-shment of 700 wives, although Conti, who sited the city several years before, gives the mber in his time as 2,000, all of whom he ates were under an engagement to submit to e rite of *sati*, or being burned alive on the ath of their royal spouse. During festivals o large Juggernaut cars crowded with iests and dancing girls were dragged rough the streets by the pious votaries of e gods, from time to time the devotees in eir religious frenzy throwing themselves der the gigantic wheels, so that, on being ushed to death by the sacred car, they ight effect a sure entry into the Hindoo radise.

In India it is always considered that the rictness with which justice is administered ay be measured by the extent to which the asses of the population wear their jewellery public, and according to this theory the untry must have enjoyed the blessing of an cellent government, as it was observed that e people of every rank from the highest wn to the very workers in the bazaars, wore wels and ornaments of gold such as earrings, cklaces, rings, and bangles. Round the ty the ground was laid out in fruitful gardens, stures, orchards, and hunting seats for the ng and nobles, a slight eminence being cupied by one of the royal residences. The ief palace, situated at the confines of the ty, judging from its present appearance, must ve been a most imposing structure. Near there were four long and spacious bazaars ch described as being built with a lofty cade and a handsome gallery. In one of these bazaars pearls, rubies, emeralds, diamonds, and other precious stones were publicly sold; it is said they were also continually provided with an abundance of choice fresh flowers greatly fancied by the inhabitants. As is common in the East, the followers of the various trades or industries lived in separate quarters, and these were supplied with streams of water flowing through stone-cut channels. On the left of the palace was the hall of justice, and near it was the treasury arranged with chambers where masses of gold ingots were stored. Behind the treasury was a quarter three hundred yards long and twenty yards broad, which seems to have been exclusively occupied by dancing girls who, according to the narration, were beautiful, rich, and accomplished. The king sat on a throne of exquisite workmanship in gold inlaid with jewels, and the walls of the throne-room were lined with thin gold plates. During the visit of the Persian envoy, there was celebrated one of the great national religious festivals know as the Mahanavami, which occurs during the time of the September full moon. On this occasion the great plain near the city was strewn with tents of varied and tasteful colours, and the temporary residence of the king was a pillared mansion nine stories high. For three days the wealthy city was in a state of high holiday, the display was a most gorgeous, highly-coloured, and thoroughly Eastern scene, for, during the holy three days, the inhabitants lived in an environment of fireworks, singing and dancing girls, jugglers, snake-charmers, processions, idol worship, eating and drinking (no intoxication), love, music, laughter, and religion—all in orthodox Hindoo style.

Under a settled government, with the rights of property well secured, the hereditary trading acquisitive instinct of the Hindoo had full scope, and an extensive commerce with other lands in Asia, Africa, and even in Europe was developed. Vijayanagar became a great mart for precious stones and pearls, which were brought from Burma, different parts of India, and from Persia, besides silks and brocades from China and Egypt. Amongst many other articles of import are mentioned oil, wine, drugs, spices, coral, ivory, and sandal-wood.

Some idea of the luxury prevalent amongst the upper classes of the Hindoos in those days may be gathered from an account of a pageant given by the Mohammedan historian Ferishta. In the early part of the 15th century Feroze-shah, a neighbouring Mohammedan potentate, having married the daughter of the Raja of Vijayanagar, paid a visit to his royal father-in-law. The latter met his guest six miles from the city, and the two princes rode back together between ranks of beautiful girls and women, who waved over their heads golden plates full of incense, the road being strewn with cloth of gold, velvet, satins, and other rich stuffs. On arrival at the palace Ferozeshah, having descended from his horse, entered a splendid palanquin set with costly jewels, and was carried to the portion of the palace prepared for himself and his bride.

Towards the middle of the sixteenth century, Vijayanagar had perhaps attained the acme of its luxury and splendour. As the residence of a wealthy court, it was the home of an opulent nobility, but it was also a seat of learning, and it was the emporium of an immense commerce. Supposed to be under the special protection of the gods, it was largely inhabited by the higher Hindoo castes, including Brahmins, and owing to this circumstance may be attributed the fact that different travellers describe the people of the city as being of an olive tint and fairer than the ordinary South Indian, for although the colour of the skin is not always an indication of caste, as a general rule the higher religious divisions are of lighter complexion than the Soodras or labouring population.

Amongst the upper classes, whether due to some supposed sanitary reason or connected with a religious observance is uncertain, a custom prevailed of having their bodies anointed at times with a peculiar unguent, composed of sandal-oil, aloewood, camphor, musk, and saffron. They wore a profusion of jewellery, and out of doors they were followed by two pages, one carrying a sword, the other an umbrella of silk with gold fringe. The men were spoken of as being well proportioned with good features, and clad in robes of cotton stuffs, silk, or brocade. The women, who seem to have been very handsome, wore a robe girt round their waists, with the upper end drawn up over the shoulder and breast, leaving one arm and shoulder bare. The headdress consisted only of natural flowers, and, as in the case of native women of the present day, they wore jewels in the nose and ears, also round the neck, arms, fingers, and waist. Both men and women wore worked sandals, shoes and stockings being unknown. During war time many of the women accompanied the armies and were spectators of the action, a custom which perhaps not a little contributed to military success.

A particularly high sentiment of perso
dignity seems to have prevailed amongst
aristocracy, as Duarte Barbose mentions th
duelling was common. Once a challenge h
been given and accepted, a time and place
the combat were appointed by the raja, w
with his court witnessed the scene. T
opponents, stripped to the waist, but below
waist with thick folds of cotton cloth wrapp
round them, entered the lists accompanied
their seconds, then each of the principals, p
vided with a sword, dagger, and buckl
having offered up a prayer to the particu
divinity he worshipped, the quarrel was foug
out in the royal presence.

With the growth of Vijayanagar—for
spread till it covered 24 square miles of grou
—its reputation for great sancity was gradua
acquired. Temples lined the river banks, a
the Brahmin priests industriously propaga
a belief, which soon became widespread,
the effect that the votaries of the gods to wh
those places of worship were dedicated, co
by simply bathing in a certain portion of
stream cleanse themselves from all their p
sins. Pilgrims now flocked in great numb
to the rendezvous, where Paganism in its g
dress, mingled with much that was picturesq
and poetic, held a gaudy and joyous cou
Yet these visitors were not by any means
variably persons in the humbler conditions
life arriving at their destination way-worn a
travel stained. The Indian pilgrims we
often princes, nobles, zemindars, power
officials, and wealthy traders, indeed from t
raja with his retainers and attendants acco
panied by trains of elephants, camels, and se
vants, down to the wandering yogi, or religio
mendicant, all classes were represented. T
influx of riches speedily created a wealt
native society and the numerous shrines
came places of resort, not only for pious i
worshippers, whose minds not being qu
at ease on account of their past
wished to make themselves safe for t
future, but it also became in the fullest sen
a pleasure resort for the Hindoo idolate
Indeed, according to my observation, t
people have a way of uniting amuseme
religious observances, business, pleasure, a
even criminal transactions, in a manner
paralleled among the members of any oth
sect with whom I have ever come into conta

Such was Vijayanagar on the eve of
terrible national calamity. In the height
prosperity, and in possession of an enormo
territory, the nation had grown careless as

uarding the possessions their ancestors had cquired ; a voluptuous life had enervated the pper classes, and long-continued success had lled them into a state of false security. As the case of other nations before and since, ey stifled the warnings of experience in the llurements of pleasure, and they arrived at eir age of folly.

It was in 1564 that several Mohammedan lers of neighbouring states lying to the orth of the Hindoo empire formed a coalition, order to effect a partition of Vijayanagar, nd a large force was collected for the purpose f invasion. The reigning Hindoo monarch, amed Rama, hearing of this project, hastily ummoned all his available troops, and marched orthwards to meet his antagonists. The two rmies encountered each other at a place called elikota, on the banks of the Krishna river, hen, after a long and desperate conflict, the indoos were routed. The raja being cap- ured, was promptly decapitated, and the oslems prepared to march on the capital.

There was consternation in Vijayanagar, hen news of the disaster arrived, and many f the inhabitants commenced to send away heir wealth. The Portuguese historian, Faria Sousa, states that a large amount of pro- erty, including gold, silver, precious stones, nd amongst which was the magnificent royal hrone of gold set with jewels before men- ioned, was packed on 1,550 elephants, and his caravan departed before the arrival of the ictorious army. On the capture of the city y the Mohammedans ensued one of the most errible episodes that have ever been narrated, ven in the annals of Eastern warfare ; for the oslems, having made a triumphant entry, ithout further opposition, for five months the apital was given over to pillage. The soldiery ere flushed with conquest, and panted for lunder ; intensely fanatical, they believed that o slaughter an infidel, and confiscate his pro- erty, were acts pleasing to the Divine Being ; he leaders were neither willing nor able to re- train the excesses of their followers ; and such ere the men at whose mercy lay the vast, ealthy, and defenceless city. The booty cquired was enormous, for, from time imme- norial, the Hindoos have observed the habit f accumulating precious metals or jewellery nd burying them in the ground, but the ictors were ruthless in their search. It is ecorded that Adil Shah, one of the Moslem eaders, secured, amongst quantities of jewels f prodigious value, two diamonds, one as arge as an ordinary egg, and another somewhat smaller. Murder, rapine, and outrage of every description, as day succeeded day, were endured by the unhappy population. Vijayanagar as before said, had become a seat of learning; but now the colleges, which had been thronged by Hindoos of the higher castes, were demolished, and the libraries, stored with treasures of ancient genius, collected during the course of centuries by the patient industry of thoughtful Brahmins, were destroyed. From the royal palaces down to humblest dwellings all were looted ; all the temples but one were desecrated by having the blood of the sacred cow spilt in them ; and at last the inhabitants, believing that the wrath of their gods had fallen upon their city, terror-stricken and in horror, fled away and dispersed through the surrounding country. Some of them, however, crossed the river Toongaboodra and settled in Anagoondi, then a suburb of Vijayanagar, where they were ruled over by one of their own princes whose line continued up to the time of the visit of our party, and whose descendant was the raja to whom we had, as before mentioned, letters of introduction.

The defeat of an army or even the temporary occupation of the capital by the enemy, need not have shattered the empire, but it did, for adequate preparations had not been made to meet an impending crisis of which there had been ample warning. There was want of cohesion amongst the leaders of the Pagans, there was not time to organise fresh defences, and the dominion broke up into fragments, some falling under the power of different Mohammedan Nawabs and others under Hindoo rulers until the British power once more effected consolidation and established an era of tranquillity.

Having only allowed ourselves one day for viewing the ruins, we could traverse but little of the locality, but on some subsequent visits I was able to make a more thorough and interesting exploration.

This part of the country is interspersed with low hills rising abruptly from the ground, and composed of loose boulder rocks, piled over each other. Two of these eminences lie within the actual confines of the city, and the tops of them being crowned with temples, the general result gives a pretty and bizarre effect. At one place there are the remains of an arena where the nobles of olden time were wont to witness wild beast fights ; elephants, tigers, cheetahs, and rams being trained to contend with each other, and thus presenting an exhibition which has always been a favourite amusement of the Hindoo race. Not far off are the remains of what I presume must have been one of the royal palaces, the zenana or part reserved for the females of the court with their slaves being surrounded with stone walls. I noticed that the ornamentation of most of the temples consisted of rich carving, representing probably scenes in the lives of certain gods and goddesses, and in one large building the walls were covered in relief with hunting scenes and other incidents in the Sanscrit heroic poem, the *Ramayana*, the four centre pillars being handsomely carved black marble. Wherever one turned, the eyes rested on wall carvings, stone effigies or mutilated fragments of such, representing deities selected from the Hindoo Pantheon. One gigantic statue of Vishnu in a sitting posture was there. It was carved out of a single stone, and was about 35 feet high. Unfortunately, however, this singular monolith was considerably damaged by the Mohammedan soldiers after the conquest. Another of the temples had a singular appearance, the massive and elaborately cut stone roof was not supported by walls, there being in fact none, but by a series of monoliths forming a quadrangle, each stone carved so as to represent an elephant standing on his hind legs, and on his shoulder was seated a god. The head of each animal supported a single stone rafter, 32 feet long by about 2½ broad, laid horizontally and supporting the massive roof; the entire effect of this as with other temples was strange, more fantastic than artistic according to European notions, but still highly characteristic of Hindoo taste.

Not far from the palace may be seen a building in comparatively good preservation, which was the bath-house of the imperial ladies, built in the Indo-Saracenic style, and formerly supplied with water from an aquaduct, of which the remains can yet be distinguished. About a quarter of a mile from the bath may be observed a group of several edifices close to each other, and one of which is known as the elephant stables. It is probable that only the elephants used for state processions were kept here. Near the arena before mentioned, there lies an immense trough carved out of a single stone; this monolith has been turned over evidently in a search for treasure; its dimensions are 41¼ feet long, by 3 feet broad and 2 feet high; it is said that one of the rajas used to have hundreds of cows milked into the trough, and then watched the elephants drinking out of it.

I noticed a temple dedicated to Vishr which was most elegantly carved in grani the richly-cut porch in particular bei considered one of the finest pieces of sto decoration in India. Near this edifice another small temple, a perfect curiosity its way, as it is not built, but actually he out of a solid rock, which was most probab originally an immense boulder, the who being minutely and tastefully carved to repr sent a large Juggernaut car. Further on, ne the outskirts of the city, there are two templ close to each other, which present a stran peculiarity in their construction. The wa are formed of massive blocks of granite, b some of them 30 feet long by 4 feet broad a let into the wall high up from the ground, th affording a proof that the native architec possessed a large amount of mechanical skil indeed, the precise manner in which the immense granite blocks were raised has n yet been ascertained with certainty. Th principal street, about half a mile long ar 50 yards wide, is well paved with flag-ston right across, there being no raised footpa along the sides, but both are lined with palace temples, and houses, which probably belonge to nobles or wealthy citizens. At differe places there were open spaces most probab occupied in former times by houses of th humbler classes, and I should say that thes dwellings may have been constructed of perishable materials, which accounts for their havin disappeared. As I rode through this deserte city, in silence broken by nothing but the foo falls of my horse, it always conveyed to me th idea of an enchanted place such as forms th ready theme for an Eastern story-teller. Ther was something weird in its utter loneliness, i the emptiness of its magnificent edifices lon untenanted by man; the stone-hewn Hindo deities, sometimes monstrous, always fantasti and strange, looking apparently with an expression of silent mockery carved on thei faces, before whom centuries ago there bowe down and worshipped and sacrificed millions o votaries, now long since passed away, wh once crowded the temple gardens and the bus thoroughfares of Vijayanagar. The singula effect of the scene I have described wa heightened by the fact that the city was no by any means untenanted, although the occupants were not human beings. A species o large grey monkey have their habitations everywhere through the buildings, and these animals clustered in crowds amongst the images of the gods, climbing in and out through the doors nd windows of those palaces which in other ays were occupied by Hindoo aristocrats. ppropriately enough at one end of the princial street was a large stone statue representing anuman, the monkey god himself.

The following morning we started at dawn, nd found that the raja, who had heard of ur intended visit, had sent to an adjacent nding place from which we were to cross the ver a number of boats, the first of this kind I ad ever seen. They were made of stout icker work, circular in shape, and covered ith ox skin, answering precisely to the escription given by Herodotus of those use on the Euphrates 2,000 years ago. Ve swam our horses across, the distance o the opposite bank being about 150 yards, nd in a few minutes were on the Anaoondi side. On landing we were met by a umber of the raja's retainers and court fficials, their snow white turbans, glittering rms, and varied Oriental costumes, all in armonious colouring, presenting an extremely ood effect. The *cortège* having formed up, a and of musicians commenced to play native usic on some peculiar-looking instruments, nd we proceeded to our encampment, the ear of the procession being accompanied—ccording to Hindoo custom—by a troop of ancing girls. The complexion of the latter as a species of straw colour; they were lender and graceful in form; they wore white uslin robes, much the same as the ancient reek dress, bound round their waists by a hin gold belt; above their ankles and on their rms they had gold and silver bangles.

It is almost unnecessary to say that in India ative men never dance; the nautch, or Indian ance, is only performed by females hired for he purpose, who belong to a peculiar caste; nd those girls who dance well sometimes make onsiderable fortunes, as their services are ontinually required; religious festivals, enterainments, and marriage ceremonies not being onsidered *en règle* without being accompanied y a nautch.

Shortly after arriving at our encampment, vhich had been pitched some distance outside he town, our servants announced that two of he princes and one of the court officials were oming to see us. They were intelligent men, aving a natural, well-bred manner, characeristic of the Hindoo aristocrats. They conersed with us for some time, and on departure aid the raja would be pleased to receive us bout noon. At the time mentioned we went o the palace, a spacious edifice enclosing two large open courts, and were shown up a flight of stairs into the presence-chamber, where sat the raja surrounded by his relations and men about the court. His Highness had a worn, faded look, and was evidently suffering from ill-health. He asked if any of our party was a medical man, and on my telling him that one was an army surgeon, he requested him to prescribe for him, saying that he would send one of his men to our encampment who would thus consult the surgeon by proxy, and after some more conversation we took our departure. For a few days afterwards we remained at Anagoondi, making excursions up and down the river, and keeping within our tents during the mid hours of the day, when the raja sent down baskets of delicious mangoes and other tropical fruits. On the morning of my friends' departure for Hyderabad, his Highness sent down his elephants on which they were to ride the first stage; and as the last of the animals disappeared amongst the foliage growing round the suburbs, I was glad to find myself the only European in the Pagan city, for I had often wished to have an opportunity of studying the character of a very interesting people, under conditions when they were not in perpetual contact with European civilisation.

My impressions of the Hindoo population of this district were decidedly favourable. In colour they were rather lighter than in other districts where I had been living, the complexion generally varying from light brown to saffron, yellow, or straw colour. Brahmins and other of the higher castes seemed to be plentiful, but very few Mohammedans. The life of the people was essentially a happy one, the balmy, warm climate and rich soil afforded to all the means of living without engaging in the fierce struggle for bare existence to which the majority in our country are condemned. The sugar cane, tobacco plant, together with the different Indian cereals and fruits, grew in rich profusion, the people were temperate in their living, for they drank no alcohol in any form; there was everywhere an appearance of comfort and ease; they all looked healthy, well fed, and well dressed. In the cool of the evening, towards sunset, the streets were thronged with people all in contentment and good humour, and I observed with surprise during that and subsequent visits that there seemed a total absence of contention. I never witnessed a quarrel, I did not see a blow struck, nor did I hear an angry word pass from one to the other; all seemed to be amity and politeness.

The town of Anagoondi itself was straggling and irregular, the houses as are generally seen in the East, with flat roofs. Side by side were those of different styles of architecture and of different sizes, in confusion; but it was a highly picturesque confusion, which was agreeably heightened by the gardens and palm trees which were interspersed through and around the place. Possibly owing to the preponderance of high caste Hindoos in the population, Anagoondi was exquisitely clean, for with the higher castes cleanliness is not next to godliness; but it is, in fact, part and parcel of their religion, and this feeling extends down, more or less, through every grade to the pariah or outcast. I saw no trace of offal or rubbish lying about, none of the people seemed in abject poverty, there were no squalid slums, and the habitations had, if I can use the expression, a species of quaint and pretty toy-house appearance, so bright and fresh did they appear with their neat verandahs running along the front, under which the families congregated in the evening. The life of the people was simple, their wants were few, and so it might be said were their pleasures; but I could see that their whole life was a joyous one, for all around nature had painted a landscape in her brightest colouring, and in that land of sunshine, the beauty of her aspect was reflected in the minds and dispositions of the inhabitants. All were most courteous to each other, and to the stranger also, for I found myself, though an alien by race and religion, and the only European in the place, as secure amongst the people as if I were in the streets of London. It is evident that when Vijayanagar was the capital of an empire, Anagoondi had become a species of fashionable suburb on the other side of the river, as the left bank, on which the latter town stands, was lined at intervals by temples and residences of the same kind of architecture as those in the deserted city. Forming a fine panoramic view, and extending along the river side, were plantations of palms, plantains, and banyan trees, through the groves of which climbed troops of monkeys and wandered flocks of half tame gaudy peacocks, both unmolested by man, for both the animals and birds are objects of worship in that particular locality.

The term of the period for which I was allowed to be absent having expired, I returned to Sundoor to resume my official duties, but I soon after obtained leave to again visit Vijayanagar when I could see it under very different conditions. I have before mentioned th after the city was occupied by the Mohammeda soldiery, they purposely desecrated the sacre resort by spilling cow's blood in the temple one only having escaped this outrage; that i consequence of an act supposed to be so r pugnant to the deities, the cow being viewe with superstitious reverence, the wrath of th gods was excited, and that the place lost i sanctity, for which reason it became desert It is believed, however, by the idolaters th for ten days, dating from the first full moon every April, the curse is taken off; the go for the above period are appeased; and th sacred portion of the river Toongaboodra on more has the virtue of being able to clean from their past sins those who bathe in i This belief is so widespread, that people of a ranks and degrees come from most dista parts of India to attend the *Jettra*, as th holy festival is called, and it was general considered that the influx of populati amounted to about 200,000 each year.

Thus the city is again inhabited, but on for the ten days above mentioned. On m second visit the roads in different directio leading to the shrines were crowded with p grims of all classes—traders, and ordina visitors; markets were established, tempora shops run up, the palaces of the nobles we once more occupied, as were some of th temples, by the visitors who came in b thousands every hour, and in others whit robed Brahmin priests were hanging lam and conducting worship as of old. The gaye time of all was by night, when the full mo of Southern India lit up the city, shining brightly that one could read the smallest pri by it. If, as I have said, Vijayanagar a peared like an enchanted city when silent a deserted, it conveyed that idea much mo when its streets were again thronged wi Hindoos; men, women and children we there, in holiday mood and holiday dres laden with jewellery, and thoroughly enjoyi themselves. There were two large Juggerna cars, which from time to time were dragged hundreds of worshippers to and fro, guard on each side by three or four peons or nati police, to prevent people sacrificing themselv by allowing the wheels to pass over them. The cars are made of dark-red wood in the form temples richly carved with figures of Hind deities, and inside of each were two or thr officiating priests. The scene that night w one of the most grandly beautiful and at th same time one of the strangest I have ev en. It is still fresh in my memory, though is one to which I fear a verbal description n hardly do justice. The entire landscape, thed in a flood of soft Indian moonlight, emed tinged with a silvery hue, the broad ver Toongaboodra shone like a sheet of frosted lver, and silver edged the mountain tops; for iles the river banks were fringed with trees, owing a wealth of deep green foliage, ingled with groves of feathery palms, and attered thickly amongst them were the pale, ranite-idol temples with their rows of sculp- red columns and statues of stone-carved ods. Once more the thoroughfares were ronged with people, who lived and dressed, nd thought and worshipped, as did the enizens of the same city four hundred years go. At one large open space, surrounded by ncient temples, and having the appearance an amphitheatre, the crowd had formed a ircle, in the centre of which were three nautch irls, who were covered with richly brocaded rees, or native robes; they had gold bangles n their arms, heavy gold necklaces and ear- ngs of rich Indian workmanship, and round eir ankles gold rings hung with small awks' bells which made a curious tinkling oise as they performed the Indian dance, mething in character with the Spanish fan- ango, which was introduced into Spain by e Arabs, who are said to have taken the lea from the dance of India.

To form a correct idea of the scene I escribe, imagine the open space I speak of, anked by two lofty pagodas standing out lear against a background of deep blue sky, e surrounding temples lit up and filled with orshippers, crowds of natives moving about every variety of brightly-coloured national ostume; throw into the picture temples, alm trees, idols, nautch girls, flower gar- nded and jewelled, white-robed priests and uggernaut cars, then some conception may e formed of Vijayanagar by moonlight during e *Jettra*. Surrounded as it was by the most vish gifts of nature, the entire scene was edolent of tone and colour, but it conveyed a eird idea, such as a highly-imaginative rtist might select for the drop scene of a eatre, and if there was a strong dash of the ntastic throughout, impressing one with a ense of what the French call *diablerie*, all of hich was essentially in Hindoo taste, that ct did not prevent the entire spectacle from eing poetic and beautiful in the extreme. It as not a little surprising that in this immense ssemblage of human beings, many of them displaying considerable wealth on their persons in the form of gold or silver ornaments, and jewellery, I observed not the slightest attempt at robbery or outrage; there was neither contention nor drunkenness, the people were orderly and well behaved; although, perhaps, for the most part, artificers, cultivators and traders, they were as well-bred as English ladies and gentlemen of good society. Government authority was represented by a half-caste police inspector, having under his orders about a dozen police peons; and for the settlement of disputes which might arise a native Tehsildar or magistrate presided, sitting cross-legged in a building, which was probably in former days a hall of justice. There were throughout the entire city only three Europeans, two missionaries and myself; yet we were able to traverse the crowded ways, filled with a population wrought up to an exalted state of fanaticism, without the slightest annoyance or insult. During the native saturnalia night seemed to be turned into day, and almost till dawn, as I lay in my tent placed in one of the temple gardens, I could still hear the monotonous music, the drumming of the tom-toms, the songs of the devotees paying adoration at some idol shrine, and above all, there swelled a loud murmur, the voices and laughter of the joyous and light-hearted Hindoos in the pleasure of their annual holiday.

The circumstances connected with the decline and fall of the Vijayanagar dominion have a significant parallel in the narratives of the wreck of other empires. In the pages of history we find that nations, if at last successful, after being hardened in a long continued struggle against adverse forces, develop qualities which make them rich and powerful, but prosperity is not always an unmixed blessing, for a widespread luxury, the outcome of an artificial life, frequently results in an age of decadence. Forgetting, that in proportion as wealth and territory augment, means should also be increased to defend acquired possessions, men refuse to make adequate sacrifices, personal or otherwise, and when a political crisis arises, the nation is involved in serious disaster or irretrievable ruin. So it was with the great South Indian state which has passed into our hands; but history sometimes repeats itself, and in guarding our magnificent inheritance in Asia, it might not be amiss to take a very palpable and useful object-lesson from the history and fate of the Empire of Vijayanagar.

DISCUSSION.

Mr. R. **Sewell** said that he felt it to be presumptuous on his part to say anything after the admirable paper that had been read; but as he had had exceptional opportunities, during a six years' residence in the neighbourhood, of visiting the place and examining the ruins of the old city, perhaps he would be pardoned for taking up the time of the meeting. There were so many things to say that he had perhaps better begin by a few words about the history of the place. Captain Rolleston told them at the beginning that the antiquity of Vijayanagar was lost in the mist of ages, and so far that was perfectly true. No one knew exactly when the city began, or when its earliest inhabitants settled there; but it was perfectly plain that almost all the remains were comparatively modern, that is, they did not date from a period earlier than 1336 A.D. There was, however, one little shrine, and one only as far as he could find, and he had visited the place scores of times, which could boast of any real antiquity. This was near a group of Jain temples, a view which had been shown on the screen. It was on the rocky hill side above the main temple at Hampi, now used for worship, and was a tiny shrine of precisely the same architecture as the remarkable rock-cut temples south of Madras, known as the "Seven Pagodas." The shrine had a waggon-roof, a perpendicular front, and an apse behind. The fact that it was entirely built of stone from roof to basement, and had no brick-work about it of any kind, proved its age, and that date was not later than about 650 A.D. The natives had a tradition that the mass of rocky hills covering the site of the old city was the scene of the rape of Sita, and the adventures of the great hero Rama. There was a little pool amongst the rocks close to the river, and a little cavern amongst the masses of boulder close by. At this place the rock sloped upwards slightly and evenly, almost as if paved, to the hills behind. A person standing on this sloping platform saw at his feet a long but narrow vein of some dark mineral traversing the entire breadth of the platform from the cavern up to the rocks behind, and this it was said was the mark caused by the trail of the *sari* or cloak of Sita when she was carried off by the great giant Ravana to his house in Ceylon. The earliest building known was, as stated, 650 A.D., but the mass of buildings dated from about 1336 to 1550 A.D. As to the origin of the empire there was not very much information available. It appeared that in the break up of all the Hindu empires of the Decan, which fell before the Mohammedan power at the early part of the 14th century, the two brothers, Bukha and Harihara, fled with probably a large following, southwards to Vijayanagar, and founded the city, but the buildings were probably not very numerous until 50 or 100 years later. Perhaps the greatest building age was 1480 to 1550 A.D. [Mr. Sewell exhibited a photograph of the lineal descendant of the old sovereigns, the present Raja of
Anagoondi, a young chief of about 25 years of ag
Various writers say that the troops of Vijayana
were excessively numerous, but it probably would
an error to think of them as very highly organise
they were probably more like an armed rabb
carrying spears and swords. Some three or f
years ago Lord Wenlock, then Governor of Madr
paid a visit to Vijayanagar, and the natives of
neighbourhood busied themselves for a long ti
before his arrival considering how best they co
show him honour. They decided, amongst oth
things, to present before him a number of the
scendants of the old Vijayanagar soldiers in their
war costumes, according to the traditions receiv
from their forefathers; and this was done. The sig
was very interesting. Considering the conservati
qualities of these people, it was probable that they
really represent the soldiers of former times. Th
clothes were dyed Indian red, the well known red
laterite soils. They were naked to the waist, but
over, from head to foot, they were daubed with t
same red colour. Their arms were rough spea
which there was no attempt to polish or clean. So
had swords and daggers, whilst many had shiel
These men stood in line, and seemed to take gr
pleasure in what they were doing. They were ask
by Lord Wenlock why they coloured themselves
that way? And the reply was, to conceal the mar
of blood. Another interesting thing connected w
this journey of the Governor was seen in the cond
of the young Raja of Anagoondi. The old dev
of the empire of Vijayanagar, shown on their copp
plate grants, and on their sculptures was a bo
When Lord Wenlock came there, the first act
the Raja was to present him with the body of a w
boar. It seemed as if the Raja remembered t
ancient emblem of his house. Captain Rolleston h
told them that Nicola Conti spoke of the king havi
2,000 wives; but that was a slight mistake, if t
quotation he (Mr. Sewell) had often seen was corre
Conti mentioned 12,000 wives, and said that 4,0
went on foot, and served in the kitchen, 4,000 we
on horseback, and 4,000 were carried on litters.
these 4,000, 2,000 were specially selected, and bou
themselves to die with their lord on his funeral pyre
to become *sati*. Accounts of Vijayanagar were le
by many travellers of old time, Vasco da Gam
D'Albuquerque, and others visited the place. Cæs
Frederick was one of the most interesting, because
visited it two years only after the great sack of t
place in A.D. 1565. Abdul Razzak, who was the
about A.D. 1400, mentioned that in a part of the ci
there were bazaars supplied with water running in c
stone troughs. He (Mr. Sewell) had visited the pla
on many occasions, and had not seen these wate
courses nor, had he heard of them from any oth
explorer, but one day he came across them. T
remains lay in a long line in a field. They were
black granite stones, beautifully polished and cu
each about 10 feet long. They lay on each side
a trench. The stones themselves were carved int

llow hollows in parts, evidently for the reception ooked rice and condiments, so that there was no bt that the people of that suburb used to sit the troughs and eat their daily meals. The great k of the city by the Mohammedans, in 1565, des-yed for ever the old empire, but representatives of royal family fled southwards, and retained a ninal sovereignty down to British times. In 1639, en the English were at Madras, and wanted a ce of ground for a fort, they had to obtain per-sion from the representative of the old Vijayanagar pire. The viceroys, who afterwards, naturally, ame independent in the extreme south, in Madura, l were known as Nayaks of Madura, held their ritories nominally as viceroys of Vijayanagar. After ir fall the whole of the country was split up into all estates, held by chiefs called Poligars, amongst om there was perpetual fighting for many years. that it was interesting to note that even at so e a date as 1793 A.D., there was an inscription ant in the Madura district, dated as "in the gn of Venkatapati Râya, King of Vijayanagar." . Sewell said that he had originally thought, as ptain Rolleston did, that the stone car at the thhalasami Temple at Hampi was a monolith, but ser examination proved that it was not so. It was lt up of several stones pieced together. It was of ne only up to the cornice, which was about 14 feet ve ground, the material being a quartzose granite. ove this was what might be called a great cap de of brickwork. A few years ago this old ckwork cap appeared very much ruined and stroyed. But about the year 1884 Mr. Black, istant to Colonel Cole, R.E., Curator of Ancient numents, restored the cap by repairing the remains the old one, and covering it all in with a sort of n of new work, afterwards covered with white cco, and so it appeared in the photograph. Mr. well noticed as early as 1884, that the stonework ow the body of the car was split in many places, ugh the splits were not very large. Years passed l the cracks seemed no larger, but about four years , when he was there, he found to his surprise and may that the structure was breaking up. The cks had multiplied and extended, some being arly an inch broad. The top and the sides were dently crushing in, and it was plain that unless nething were done the whole would collapse. at once called in a skilled engineer to see what uld be done to save the car, and the professional ort was, that if the stonework were not relieved m the superincumbent mass of brick, complete molition of the whole must result. The top weight ng removed, and the roof shored up from inside, few iron pins and rivets would keep all together, d the old car would be safe for many years. But s must be done at once. He, therefore, sent a report to the Government on the subject, d stated his opinion that the work was essential to done, and done at once, and that as the old brick-rk was for ever hidden by the new skin of brick and plaster which had been placed over it, no great archæological injury would be done, otherwise the beautiful stonework would fall to pieces. The Government of Madras adopted this view, and the work was carried out. The present appearance of the structure might be considered hideous, but, at any rate, it was safe. The brick cap was gone, but the entire stone remained secure. Mr. Sewell said he was glad to make this explanation publicly in England, because a very strong opinion had been expressed at one time that he had been guilty of an act of vandalism in touching the car at all. All he would say was, that if this cap had not been removed, at the present moment there would have been no car in existence at all. He acted for the best. Captain Rolleston had called attention to the enormous statue which was often designated a "statue of Siva," but it was really Vishnu, in the Narasimha Avatar, or incarnation, half-lion and half man. The two pillars with cross pieces had been alluded to as being connected with Buddhism. Mr. Sewell believed it to be much more modern, and to date from the flourishing period of Vijayanagar art. It was the place where the old kings used to perform a ceremony, which was still gone through by some of the great rajas in the south of India, such as the Maharaja of Travancore. The king sat in a pair of scales, the other scale being filled with gold, against which he was weighed. After the weighing had taken place the gold was distributed amongst the Brahmins. This stone structure was made for the purpose of holding the scales, and in the centre of the beam could be seen the hole where the scales were attached. Mr. Sewell concluded with an apology to the reader of the paper for having contradicted him on so many points, but he hoped he might be forgiven, considering that Captain Rolleston had not seen the ruins for so many years, while he (Mr. Sewell) had made a special and very recent study of them.

Mr. DAVID CARMICHAEL said this territory or kingdom was the youngest and greatest of those that flourished in Sourthern India, where there had been some very remarkable kingdoms. First, there was the Pandya kingdom, in Madura, so ancient that they thought themselves big enough to send an embassy to Augustus Cæsar. Then there were the Deoguri, referred to by Ptolemy, and the great empire of Andhra, which was spoken of by Pliny, to the effect that the king possessed 30 walled cities, 100,000 fighting men, 10,000 horses, and 1,000 elephants. It was suggested that these people ruined themselves by excessive luxury, and could, therefore, make no stand against the Mohammedans, but he did not think that was quite correct. They defeated the Mohammedans several times shortly before, and when the city was taken it was effected by a stratagem, the attacking force making a feint of attempting to cross the river at a ferry some way down, and having drawn away the troops, they suddenly returned in the middle of the night to the town, and effected a passage; besides that, the raja's elephant was killed by a stray shot, which had a very disheartening effect upon the Hindoos. Again, the Hindoos had in their service two Mohammedan generals, who at the critical moment went over to those of their own faith, just as at the battle of Plassey one of the Mohammedan generals went over to Clive. The names of several travellers had been mentioned who had visited Vijayanagar, and many quotations from their writings would be found in Mr. Lewis Rice's "History of Mysore." He did not know whether the Government intended taking any steps to preserve these wonderful old buildings, but he certainly thought they ought to, in the same way as the Italian Government preserved the remains of Pompeii.

The CHAIRMAN then moved a cordial vote of thanks to Captain Rolleston for his interesting paper. He could not think of touching on any of the numerous details referred to in it, but he might observe that it exemplified very clearly how much more vivid was the impression produced upon the mind of a thoughtful observer who had only sojourned for a year or two amidst such scenes than was often the case with those who lived there for a very long time.

The vote of thanks was carried unanimously, and the meeting adjourned.

NINETEENTH ORDINARY MEETING.

Wednesday, April 29, 1896; Francis Cobb, Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Reeve, Henry, Anglo-French Boundary Commission, Upper Gambia.
Gearing, Ernest, R.N.R., Penshurst, Clarence-drive, Harrogate.

The following candidates were balloted for and duly elected members of the Society:—

Bond, Hon. Robert, St. John's, Newfoundland.
Deadman, Henry Edward, Boscombe, Nightingale-lane, S.W.
De Bunsen, Moritz Ernest, British Legation, Bangkok, Siam.
Jacolette, Martin John, 40, Harrington-road, S.W.
Mott, Basil, 8, Queen Anne's-gate, S.W.
Simson, Alfred, 4, Fairlie-place, Calcutta.
Trollope, John Evelyn, 28, Craven-street, Strand, W.C.
Wilkins, Joseph Edwin, 5, Suffolk-street, Pall Mall, S.W.
Youlten, William, 159, Victoria-street, S.W.

The paper read was—

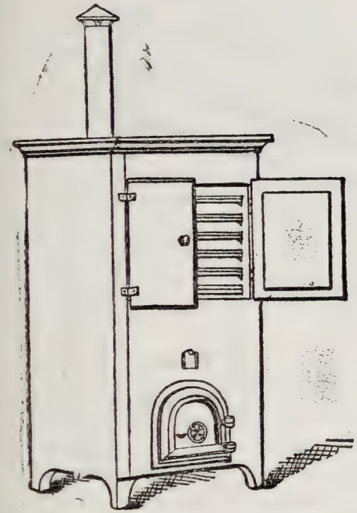
FRUIT AND VEGETABLE DRYING.

By EDWARD W. BADGER, F.R.H.S.

I wish to preface what I have to say abou fruit and vegetable drying by a few word respecting the general scope of the paper whic I have the honour of submitting to you. In th first place I desire to state that I have nothin new to disclose, and that all I have to say i well known to those who are acquainted wit the methods of fruit drying practised in differen parts of the world. The purpose I have se before myself in writing this paper is to giv information about a particular mode of desiccation applicable both to fruit and vegetables which is in common use in many parts America, Germany, and elsewhere, and migh in my opinion, be beneficially used generally i this country. This process is called evaporating. For the information of those who ar unfamiliar with this process and to enab them to judge of its merits I shall describ what an evaporator is and how it is manipulated, and I shall give some details of the kin of work it can do. I shall also endeavour t show why evaporated fruit is to be preferred t that which is dried in the open air by sun-hea or in kilns or ovens by fire-heat.

It is common knowledge that in good fru years there is at certain periods an over abundant supply, or glut, of our home-grow hardy fruits, when prices rapidly become so un remunerative that large quantities of apples pears, plums, &c., are often left to rot on th trees, simply because it does not pay th grower to gather and market them. This stat of things has occurred again and again durin recent years. American fruit-growers used t suffer from the same evil, but about thirt years ago they applied themselves with characteristic energy to finding out a remed and were not long in doing so. The remed was found in drying, or, as they say, evaporating the surplus fruit in a specialise apparatus by artificial heat, whereby it i converted at a small cost into a commodit which can be kept perfectly sound and marketable for many months, and, if necessary, fo years. They found they were thus enabled t wait for a market until the supply of fresh frui ceased or greatly diminished. This metho was at first tried on a small scale only, and i a somewhat rough and ready fashion; bu experience soon suggested improvements, and it was not long before the appliance I am about to describe was evolved, and rapidly me into general use. As the demand for it ew, many forms of evaporator were manuctured, the principle being the same in nearly l, with an important exception, to which I shall esently refer. In most fruit-growing disicts of the United States the evaporator is w in general use, and evaporated fruit is an ery-day article of food in hotels and private uses. The production and consumption is very considerable, that in New York, hicago, and elsewhere, there are now many nportant firms of commission agents, whose pecial business it is to receive large consignents of many kinds of out-door fruits direct om the growers and evaporaters, which they eadily dispose of in the States, or export to ther countries. But it is not fruit only that is evaporated, vegetables of nearly all kinds are so preserved, those most usually done being peas, beans, potatoes, sweet potatoes, spinach, carrots, sweet corn, turnips, and onions; these are all popular kinds, and are much used for ship stores, both in the navy and in the mercantile marine, also at military frontier stations and in the Colonies.

FIG. 1.



ZIMMERMAN EVAPORATOR, NO. 1.

There are, as I have already intimated, many manufacturers of evaporators in America, and each maker naturally claims that his apparatus is the best. Not one of them, so far as I know, is without some merit, but there is no reason why we should trouble ourselves on this occasion with a discussion of their several good or bad qualities. For all practical purposes they may be classified into two types—

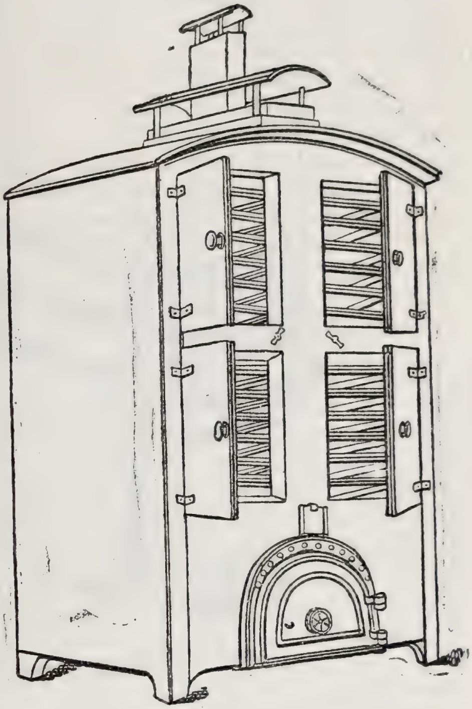
1. The Upright or Vertical Evaporator.
2. The Oblique or Inclined Evaporator.

Figs. 1 and 2 are outline sketches of the "upright" type, and Fig. 3 of the "Inclined" type (p. 542).

The "Upright" evaporator I have selected for illustration is known as the "Zimmerman." It is manufactured by the Zimmerman Company at Cincinnati. This evaporator is constructed almost entirely of galvanised iron. Its general form will be seen on reference to the illustrations.

It is made in several sizes, which are described in the company's trade list as No. 1, No. 2, No. 3, &c. No. 1 (Fig. 1) is an outline sketch of the smallest size made, and costs at the works £5 5s. It is intended especially for family use, and is so constructed as to be usable either as a fruit evaporator or, by aid of a simple contrivance, as a baking oven. It is large enough to dry from three to five bushels of apples per day, or to bake eight to ten loaves of bread at a time. It is 4 feet high, 26 inches wide, and 2 feet from back to front. It is supplied with six galvanised wire trays, on which the fruit is placed to be evaporated,

FIG. 2.

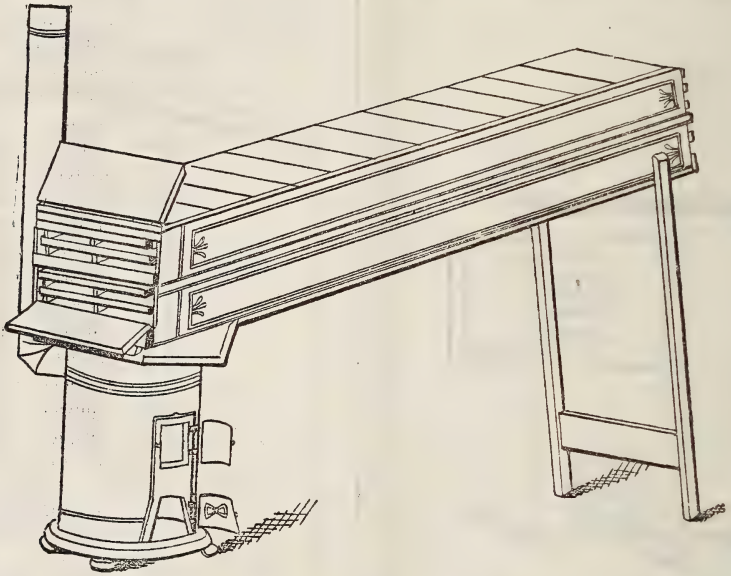


ZIMMERMAN EVAPORATOR (LARGE SIZE).

the drying surface thus provided being rather more than 20 square feet. In appearance this dryer is much like an ordinary stove. At the bottom is the furnace in which coal or wood can be used as fuel. The smoke is carried off by a pipe at the back of the dryer. The evaporating chamber is placed vertically above the stove or furnace in this and all other evaporators of the same type. The admission of air is regulated by dampers. The air when heated by contact with the furnace, passes among the fruit, and out through a covered chimney at the top of the chamber; thus there is a continuous upward current, which in the larger dryers is increased by so connecting th smoke-pipe with the ventilating-pipe that th ascending current from the furnace helps th upward draught. The drying trays rest upo ledges fixed on the sides of the drying or ho air chamber.

The dryer No. 2, which is double the capaci of No. 1, and 5½ feet high, is also both drye and baker. Its cost is £10 10s. This is th size most generally sold for private use. It wi dry from five to seven bushels of apples pe day. No 3 is a larger apparatus, stand 6 feet high, 38 inches wide, 37 inches deep has 24 wire trays, each 15 inches by 24 inches supplying 85 square feet of drying surface. The drying space is divided into two chambers, the smoke-pipe being carried up between them. It has about double the drying capacity of No. 2. Its price is £21. This is the one most generally used by dryers for market on a moderate scale. Larger sizes, No. 4 and 5, are called factory dryers. No. 4 will dry from twenty to thirty bushels of apples per day, and costs £35. No. 5 will dry from thirty-five to fifty bushels per day, and costs £52. It is the same size as No. 4, but differs from it in being fitted with an elevator, by means of which the racks or drying trays are gradually lifted from the bottom to the top of the drying chambers, whereas in all the smaller sizes the trays are stationary.

FIG. 3.



THE "AMERICAN" EVAPORATOR.

The second type of evaporator of which I give an illustration (Fig. 3) differs from others I know of in this respect: the hot-air or drying chamber is fixed at a small angle in an inclined direction away from the stove or furnace; and it is in this type of evaporator that the important exception to the general principle on which the other evaporators are constructed (to which I have recently referred) will be found.

This, which is known as the "American" evaporator (Dr. Ryder's patent), was first made at Waynesboro', Pennsylvania, by the

American Manufacturing Company. For Europe and the Colonies, it has for some years been made under license in Germany. For its introduction to England we are indebted to my friend, Mr. A. Ludwig, 16, Mincing-lane, London; and I understand that this gentleman hopes that before long the evaporator will be manufactured in this country by a private firm or public company so as to make it unnecessary to import it from Germany. Fig. 3 is a rough sketch of this evaporator. The American Manufacturing Company thus describe its merits :—

> "By a process, contrary in effect to that so long practised, *faute de mieux*, by the old school dryers, we, by the direct action of heat in the primary stages, fix the essential oils to which aroma and flavour are due. At the same time, by the action of the automatically diffused currents of hot, dry air, is developed an artificial cuticle, or parchment-like skin, and thus hermetically sealing the cellular formation containing the volatile essential oil, on the perfect retention of which so much depends. . . . By our method we likewise prevent any retrograde effects, for the evaporation is continuous to the finish, which takes effect at a reduced graduated point of temperature, and, while the automatic discharge, seriatim, of waste vaporous matter is effectually provided for, we likewise ensure a succession of currents of fresh, dry, hot air, which automatically pass underneath, diagonally through, and then off, over the trays inside the inclined automatic flue."

The currents of hot air passing through this evaporator, when in full work, are said to be "self-created and continuous, strike the trays at a uniform upward angle with considerable velocity, quickly absorb all moisture, then pass off out of the evaporator." The "American" is made in a number of sizes; the smallest, No. 0, is made for family use or limited operations only, and costs £6 10s. to £8 15s., according to the number of sets of trays required; No. 1 has a surface drying capacity of 35 square feet, and the price is £13 to £17.

No. 2 is of rather more than double the capacity of No. 1; price, £19 10s. to £26. The evaporators of a larger size are called "commercial sizes." Of these, No. 3 has a drying capacity of 300 square feet, and is capable of drying from forty to fifty bushels of apples daily; the price is £52 to £70. Still larger sizes are made when required. All through this paper a day may be taken to mean twenty-four hours, as when an evaporator is set to work in the States it is usually kept going night and day. Except the furnace fittings, the "American" evaporators are chiefly made of wood, which the makers claim to be the best substance for the purpose, and it is stated that the insurance record shows that they are quite safe from injury by fire under ordinary circumstances.

This evaporator is the kind best known in England, and a small number are in use in different parts of the country. One of them is on the estate of Mr. Ricardo, Bromsberrow, Ledbury. This gentleman's gardener, Mr. W. Trotter, has become a most expert evaporator of fruit, vegetables, herbs, &c., and wherever he has exhibited these products he has always gained the highest prizes offered for competition, for instance at the Royal Horticultural Society, the Agricultural - hall, the Crystal Palace, and elsewhere. By the courtesy of Mr. Ricardo I am enabled to exhibit here to-night specimens of fruits, &c., evaporated by Mr. Trotter. Later on I shall have the pleasure of reading to you some notes of Mr. Trotter's experiences, and his opinion of the value of the apparatus.

The "American" evaporator has been exhibited at several agricultural shows, including that of the Royal Agricultural Society at Nottingham, in 1881; and again at the Windsor Jubilee Show, in 1889, where it was awarded the society's prize of £30. The size which won this prize was the No. 2 evaporator (Fig. 3 in my illustrations), and is the one I consider most suitable for average requirements. In vol. 1, pp. 494-6, of the *Royal Agricultural Society's Journal* (1889), there is a most favourable report on the trial made at Windsor, where the judges appear to have been quite satisfied with the performance of this evaporator.

One of these No. 2 "American" evaporators was presented to our Royal Horticultural Society through the influence of Mr. Ludwig, and has been fixed in their gardens near Turnham-green since 1891. Some public and successful demonstrations of its usefulness have been made, and one which took place in July, 1891, and which I will presently describe, was attended by a large number of influential gentlemen interested in horticulture and particularly in fruit growing.

It has always seemed strange to me that the publicity given by these demonstrations, and the many letters which have appeared in the leading newspapers, have not led to a more general use of evaporators in this country. In Germany it is far otherwise, for they are manufactured there in large numbers, their use has been constantly extending for years, and the director of the "Royal College for Fruit and Vine Culture and Horticulture in General," at Geisenheim on the Rhine, not only uses them, but has written and published a book in which the methods, uses, and benefits of evaporation are set forth and strongly recommended. It is not improbable that a translation of this book will be published in England. It will doubtless be remembered that a report appeared in the London newspapers in December last, to the effect that the Financial Secretary to the War Office had stated that dried (*i.e.* evaporated) vegetables, which could only be procured in Germany, and which had been recommended by the military authorities, had been purchased for use in the Ashanti campaign. I shall be able to show you later on that vegetables can be just as well dried by evaporation in this country, and that they have been done experimentally with entire success. They are also dried very extensively in the United States.

From careful notes of the "American" evaporator, made when I saw it at work at the Chiswick Gardens in July, 1891, I transcribe the following description:—The evaporator consists of (1) a well-constructed stove in which there is a furnace that consumes any kind of fuel, coal, coke, wood, &c., and so creates the required degree of heat. This furnace is very manageable and only needs ordinary intelligence to make full use of its considerable powers. From this proceeds (2) an iron pipe through which the smoke escapes. This pipe may be lengthened or shortened as may be required. Above the stove is (3) a chamber in which the cold air is heated to any degree of temperature required. The air being properly heated ascends into (4) the trunk (consisting of two flues) which rests on the stove at an angle slightly inclined. This is the special feature of the "American" evaporator on Dr. Ryder's system, in which its undoubted superiority consists. Nearly all other kinds have the evaporating flues arranged perpendicular to the stove at their base, and the hot air proceeding through them is more or less deflected by the fruit placed on the trays, and is hindered in its natural progress upwards. Moreover the hot air becomes saturated with moisture derived from the drying fruit, and consequently becomes less efficient for drying purposes. In the "American" evaporator, the flue being inclined, this serious defect is absent. The hot air first plays about the lowest trays fruit in the evaporating flue, and then ascen upwards and does a further amount of dryin as it ascends the flue, on reaching the end which it escapes, carrying with it the extract moisture.

Apples only were evaporated on the occasi referred to, and those were Tasmanian one no others being obtainable at that time of yea By means of a most ingenious and inexpensi little machine, the apples were rapidly pare cored, and divided into slices or rings. Th prepared apples were then dipped into bucket containing water, in which a sma quantity of salt had been dissolved (1 l of salt to 20 gallons of water is abo the usual quantity used.) The rings we next placed in single layers on shallo trays, made of wooden sides, with bottoms galvanised wire-cloth of somewhat small mesh A tray (which I will call No. 1) having bee filled with fruit, was placed in the ascendin evaporating flue of the trunk at its lower en immediately over the hot-air chamber abo the stove. In about five minutes a second tra was filled, and was placed immediately unde tray No. 1. Then a third tray was filled, an placed under No. 2. Three trays, one abov the other, were all the evaporating flue woul hold in height. A fourth tray being ready t place in the flue, trays Nos. 1, 2, and 3 wer pushed forward, to admit of its entrance; the trays 5 and 6 were placed underneath No. 4 and these were pushed forward, and othe trays entered, until the entire flue was filled Trays Nos. 1, 2, and 3 having reached the en of the flue (where thermometers were placed o each side, to show the exact temperature), the were carefully examined by the operator, t ascertain if any of the fruit upon them wa sufficiently desiccated. All rings in that condition were removed into bags or boxes, an as enough were removed from the first thre trays to leave one empty, that was withdraw for use again at the lower end, and the secon series, having been examined, three trays wer placed in the descending flue, and so on, unti the whole of the first batch was completely finished. Meanwhile, a new supply was placed in the ascending flue at the entrance end; and so the work went on, until all the fruit was dryed in a satisfactory manner. The entire process lasted about two hours. On October 5 and 6, 1892, another demonstration took place at the Royal Horticultural Society's Gardens, which was attended by representatives of the Board of Agriculture, the India-

ce, and some of the Colonial Departments,
l the results were so satisfactory, that the
:iety awarded the makers of the evaporator
ir silver-gilt Knightian medal.

t is often supposed that all processes of
'ing fruit yield similar products, but this is a
sleading notion. There is, on the contrary,
ıch difference in the quality of fruit that is sun-
ed or kiln-dried and that which is dried in
evaporator. Sun drying is still much used
California, but is being rapidly superseded
the more scientific process. The best
planation I have met with why evaporated
it is superior in quality, is that given by an
inent American scientific man, Dr. J. F.
mons, of Fayetteville, Arkansas, in an address
livered by him to an important "Associa-
n of Fruit and Vegetable Evaporators;"
the pursuit is of so much importance in
nerica that the members of the trade band
emselves together for the protection and
vancement of their joint interests.

Dr. Symons says :—

> "I will now describe the process of true evapora-
> n. It has been found that by removing a part of
> e water rapidly, in swift-moving currents of air,
> ated from 240° Fahr., a different product is the
> sult, wholly unlike the fresh or sundried fruit; and
> ich will keep better, is more digestible and nutri-
> us, is less acid, and will sell for more in the
> arket. But if, after having heated the air hot
> ough, there is not sufficient circulation, or the
> rrents not rapid enough, the fruit will cook and
> en dry, or burn the same as in a close oven. Apples
> ill cook in boiling water at a temperature of only
> 2° Fahr., or bake in an oven at 225° Fahr.; but if
> e heated air circulates fast enough, the fruit will
> t cook or burn or become itself heated to the
> mperature indicated by the thermometer, even at
> 0° Fahr., for the evaporation of the water is a
> oling process, and every particle of vapour
> aving the minute cells which contained it carries
> ith it also a large amount of caloric in a
> tent form, and thus keeps the heat of the apples
> r below that of the surrounding air. The chemical
> anges which belong to truly evaporated fruit will
> ow begin, and the albumen, instead of being slowly
> ried, is coagulated precisely the same as in an egg
> hen boiled. The soluble starch existing in all fruit,
> nd composed of $C_6H_{10}O_5$, will, if the heat is high
> nough, combine with one equivalent of water
> H_2O), so that now we have an entirely different
> ompound, to wit, glucose, or fruit sugar, which will
> ssist in the preservation of the fruit, instead of being
> able to decomposition, as dried starch is in sun-
> ried or slowly dried products. All the pectine or
> uit jelly remains in the cells undecomposed, or is
> eft upon the surface by the evaporation of the water
> n which it was dissolved, and may be seen condensed upon the surface, instead of being decomposed, and passing on with the starch and gluten into the acetic fermentation. The diastase or saccharine ferment contained in all fruit, and which is the primary cause of its decay, has been rendered inoperative, and all germs of animal or vegetable life have been destroyed by the high heat. It is by this chemical change which I have briefly described, in uniting a part of the water already contained in the fruit with the fruit starch, that these truly evaporated products are rendered more wholesome, more digestible, more indestructible, and are thereby made more valuable, not only as articles of food, but because they are not subject to deterioration and loss. And it is also the reason why a bushel of apples will make more pounds of evaporated fruit than can be made by sun-drying it, as a portion of the contained water which would otherwise be lost is retained by combining with the starch to form glucose, and the carbonic acid, which is always lost in the slow decomposition resulting from sun-drying, is retained in its natural combination with the other substances composing the fruit, and hence it is heavier. These profitable and healthful chemical changes which I have mentioned are all in accordance with the laws of nature, and are certain to take place if the necessary conditions of heat and air, as I have detailed them, are properly supplied, otherwise you will have a different product; and no matter how fine your apples, how perfect your paring, coring, and trimming, or how white you may have bleached them, you have not made truly-evaporated fruit; and no matter how many have been deceived by its bright colour, or full weight, or fancy packing, your fruit will not stand the test of long keeping in warm, damp weather. The natural starch, gluten, and albumen of the fruit, instead of being cured or made indestructible by the chemical changes which constitute the difference between the evaporated and dried fruits, will absorb moisture from the air, will swell or increase in bulk, and be attacked by mould, will absorb additional oxygen, and finally sour and decay."

It must not be supposed, from the description given of the method of drying apples, that precisely the same plan will be equally successful with all other fruits, for it certainly will not. And here will, perhaps, be the proper place to draw your attention to a point of much importance to every one entering on the work of evaporating, namely, that it is not a rule-of-thumb business, but a pursuit requiring skill, knowledge, and experience. Nothing could do more injury to the best intended efforts to extend the practice of evaporating in this country, than to let anyone enter on the business with an idea that it can be carried on to a successful issue without skill, knowledge, and experience. It cannot. Without these indispensable qualifications the result must be certain failure with the further result of bringing discredit upon a valuable process and the apparatus by which it is carried on. The difference between dried fruit which has been so skilfully operated as to bring into exercise the utmost powers of the evaporator and develop the best qualities of the fruit, and fruit evaporated by an incompetent or careless operator, will be found as great as that between sterling silver and worthless dross. On the other hand, let me say that the way to perform the operations of evaporating perfectly may be readily learned by any person of intelligence who will take pains and be willing to learn from those who can teach.

To illustrate the remark I made a few minutes ago, that the method of drying apples will not serve for all other fruits, I will describe how to treat strawberries, one of the most difficult fruits the evaporater has to deal with. I am indebted to Captain J. Addison Smith, of California and London, a gentleman of great experience in fruit evaporation, for the following method :—"Strawberries are rather difficult to treat, but when properly done are not only a very delicious product but a very handsome one. They have to be, what may be termed, semi-conserved and crystallized. The berries must be gathered when coloured, but still quite firm, and placed in a broad flat-bottomed vessel. As they are liable to mash and bleed, too many must never be put in one vessel. Make a syrup of 2 lbs. of white granulated sugar to 1 lb. of water which boil until the sugar is thoroughly dissolved. While the syrup is boiling hot pour it carefully over the berries and keep them covered until perfectly cool. Then take the berries out with a flat perforated ladle, thoroughly drain them and turn on to a fine wire screen; place in the evaporator and dry with a moderate heat. In some cases, where the berries contain much water, the scalding process should be repeated. This is an operation which requires skill, but when well done, a most delicious conserve is produced." I give this recipe only to emphasise the fact that different fruits and different vegetables require varied treatment; but I will not weary you with more information of this kind, as my purpose to-night is not to describe the art of manipulating the evaporator in detail, but to draw attention to its useful powers in a general way only.

For the information of those who may wish to read the available literature on the subject, I may mention that several articles on fruit evaporation have appeared in the *Journal of the Royal Agricultural Society*. In the p
for October, 1888, there is a very interesti
paper by Mr. D. Pidgeon, a gentleman officia
connected with the society, and another in t
number for March, 1890. In the *Journal*
the Board of Agriculture for Decemb
1895, the subject is dealt with at some lengt
From Mr. Pidgeon's first paper I quote t
following particulars :—

> "A bushel of green apples, weighing about 50lb
> can be dried at a cost of from 6d. to 7½d. The tot
> cost of the dried product is from 3d. to 5d. per l
> and the average selling price from 3½d. to 6d. per l
> One bushel of green apples produces about 6 lb
> of dried apples. One pound of coal is consumed
> evaporating enough green fruit to yield one pound
> dried fruit. . . . The cores and parings are dried a
> sold for jelly-making, realising about £4 per ton.
> bushel of apples yields 30 lbs. of 'meat,' and 20 lb
> of refuse (cores, &c.). The 30lbs. of 'meat'
> reduced to 6 lbs. by evaporation, and the 20 lbs.
> refuse to 4lbs."

In America the total value of evaporate
fruit produced and sold annually must amou
to a very large sum of money, but I have bee
unable to get any reliable estimate as to ho
much it is. Mr. Pidgeon furnishes the follow
ing figures for California alone :—Total weigh
of all kinds of fruit evaporated in that Stat
during 1888, 31,450,000 lbs.; the value o
same being £431,590; but the quantity no
is much larger.

The western portion of New York State, in
district lying within a radius of forty mile
around the city of Rochester, produced i
1888, 37,750,000 lbs. of evaporated fruit (al
but 750,000 lbs. of which were apples) of th
value of £297,000. Mr. Pidgeon states tha
to produce this amount 250,000,000 lbs. (110,00
tons) of green apples and 250,000 quarts o
fresh raspberries were operated upon; 19,00
tons of coal were burnt in 1,500 drying
houses (each containing one or more evapo
rators of various sizes), and 45,000 hand
were employed during four months of th
year, bringing about the result quoted above
The use of the evaporator since 1888 has greatly extended, and it must be remembered that the figures about the produce in and around Rochester eight years ago do not represent the amount of business now done. In the *Journal of the Board of Agriculture* for December, 1895, at p. 295, a Table is given of "Imports of Fruit; unenumerated; preserved without sugar," and the quantity received in this country in 1894 from the United

ates is stated to be 6,255,046 lbs., and value £75,843. The writer of the article in ich this Table is given intimates that the crease as compared with the year 1885 (the ports of which are also given), "is due to e extension, particularly in California, of the actice of evaporating or desiccating apples, ums, peaches, nectarines, and apricots, by eans of solar or artificial heat."

The use of evaporated fruits in this country—hether of foreign or home production—will ry probably be greatly increased when the st modes of utilising them are more gene- lly understood, for they require practically tedious preparation, are always ready for e when wanted, and are economical, for the ices are low and there is absolutely no aste; and, as all who have tried evaporated uits of a good brand will testify, they are ite as pleasant to the palate as fresh fruit. ut however good they may be intrinsically, e cook must understand what to do with em, and do it, or they will be unjustly found ult with. We have only to remember that e evaporating process deprives the fruit of arly all the water it contains in its raw state see that before cooking the water must be placed. This involves soaking the fruit from to 16 hours in as much water as it can sorb, and results in a single pound of dry ple rings being increased to five or six times e weight, in a softened and juicy state which ill bake, boil, or stew like fresh gathered uit, except that it will be so tender as to quire much less cooking. The retail price of e dried rings at the present time is 7d. per ., so that the cost when ready for cooking ill be only a trifle over one penny per lb. many shops printed directions how to pre- are the apple rings, &c., for cooking are now pplied to purchasers. It would be easy for e to enumerate directions how to make armalades, jams, jellies, &c., from evapo- ated fruit which would be at least equal to e best made from fresh fruit, but I shrink om wearying you further.

I will not attempt to account for the singular pathy shown in England so far with reference the "American" evaporator. Its merits ave been officially recognised by the Royal gricultural and Royal Horticultural Societies; e journals of both societies, and also of the oard of Agriculture (as I have already ointed out) have published articles setting rth its claims to public attention, and point- g out the advantages which would un- oubtedly accrue if it were judiciously used in this country. Innumerable letters and articles have appeared in the *Times*, *Standard*, *Midland Counties Herald*, and other journals advocating its adoption, and yet the number of evaporators in use in England at the present time does not, so far as I have been able to ascertain, reach to a score. We are always slow to change and often look suspiciously at new things, and it will probably require a good deal more dogged persistence on the part of those interested before our fruit growers will welcome in earnest this transatlantic stranger. And yet I cannot help thinking that it might materially help to make fruit growing a much more profitable and less uncertain business than it is at present. What a difference it would have made to numbers of people during the past year if all the plums and damsons grown in England, which were sold at a ruinous price, or were not gathered at all, had been dried in evaporators and had since been sold at 6d. to 8d. per lb. retail; the growers would have been better off and much delicious fruit might have found its way during the past winter and spring months into thousands of homes, and a large quantity still be left for future consumption.

I asked Mr. Trotter to give me the results of his experience in Herefordshire of evaporating, and I think his communication will interest you. Here are my questions and his answers:—

Q. What kinds of fruit have you successfully dried?

A. Apricots, apples, black currants, cherries, figs, pears, and plums.

Q. What kinds of fruit have you not succeeded with, and what do you think was the cause of non-success?

A. Raspberries and strawberries. Want of experience and the lack of fine meshed cloth to place under them. I have only tried these fruits once.

Q. Have you successfully dried vegetables; and if so what kinds?

A. Yes: asparagus, French beans, peas and tomatoes.

Q. Have you cooked any of the dried vegetables, and how did they turn out?

A. Yes; excellently.

Q. I think you have dried various kinds of herbs, &c. What kinds have you had most success with? Do they retain their colour and flavour?

A. Basil, camomile, lavender, marjoram, mint, parsley, tarragon, thyme, sage, &c.

Q. Have you sold any dried fruits, dried vegetables and dried herbs?

A. Yes: fruits and herbs. Of herbs a quantity. Not vegetables at present.

Q. Taking cost into consideration, has what you have sold yielded you a profit?

A. Dried fruits, yes. Dried herbs, decidedly yes. Apple rings, in a plentiful year, pay well. Herbs also pay well.

Q. How do you pack your dried fruits, and do you sell them to wholesale or retail customers?

A. I pack the fruit in wood boxes, about 2 lbs. in each; in boxes like those used for Fry's Cocoa. The herbs are packed in half-pint glass bottles with metal stoppers, and are sold at 6d. each; also in penny packets. These are the retail prices. I sell to wholesale and retail customers.

Q. Will you tell me your opinion of *the* evaporator as a means of adding to, or entirely earning a living; and do you recommend the average fruit grower to set up an evaporator?

A. (1) I believe the evaporator to be the thing really wanted in this country, especially in a place like this where we have a quantity of fruit which can be dried for future use. Here we have used our own dried goods all the winter and have still [April] a considerable surplus which but for the evaporator would have been wasted. (2) Yes, in conjunction with a factory or jam maker, or in a co-operative way. (3) I do not recommend each and every grower to set up an evaporator, for several reasons; but I certainly recommend it for use on a co-operative method."

Mr. Trotter's suggestion that the evaporator should be used under some co-operative arrangement is deserving of careful consideration. That method would minimise risks, secure more successful results, and would probably lead to the employment of the best class of operator. At present skilful operators are few and far between in this country; but once there is a demand they will undoubtedly be forthcoming. The work would be found interesting, and, as I have previously said, it requires skill, knowledge, and experience. Much of the work might be done by women, who properly trained would prove very successful manipulators.

It now only remains for me to bring my paper to a conclusion by making a few general observations, which shall be as brief as possible.

1. The universal use and success of the evaporator in America and other countries seems to me to afford reasons for thinking that the extension of its use in England deserves warm encouragement. I do not think there can be a doubt as to the advantage it would be to fruit growers, and the community at large. On the whole it seems probable that it would be more economical and profitable if the process of evaporation were carried on by a co-operative combination rather than by a number of individuals, each on his own account.

2. It must be borne in mind that the evapo
tor will not make a good product out of frui
bad quality. The fruit to be evaporated m
be of good quality to begin with, and con
quently the fruit grower who adds an evapora
to his trade plant must take care to grow th
varieties of fruit which will produce a mark
able commodity when dried. Thus the be
kind of apple rings can only be produced fr
the best kinds of cooking apples.

3. Then the men or women employed to w
evaporators should be well instructed in t
operations they have to perform, and shou
be handy, observant, and resourceful. Tho
who are the best qualified, most skilful, a
painstaking will naturally produce the b
results.

4. The grading of fruit is another point
importance. We are not careful enough
England in this respect with our raw fruits;
would be better if we were; but in evaporat
fruits it is indispensable, and neither this n
any other point tending to secure excellen
and uniformity of quality must be neglected
the evaporater, who intends to secure a rea
sale and the highest price for his goods. Thu
the packing of the fruit must not be done in
careless or slovenly manner, but as neatly an
attractively as possible. The American metho
is to send out the fruit in neat, inexpensi
boxes, holding 50 lbs. If this would be to
large a size for this country, we must use
smaller size. The wholesale produce mercha
would be able to give the best advice on th
point.

I wish, in conclusion, as one proof of the i
terest felt in the subject of this paper, to dra
attention to a prize of £50 which the pro
prietors of a London newspaper, *The Iron
monger*, have generously offered for compet
tion at the coming meeting at St. Albans o
the Bath and West and Southern Countie
Agricultural, &c., Society, "for the bes
machine for drying fruit and vegetables," an
it is to be hoped that the liberal prize offere
will secure a spirited contest. Every competi
tor must submit his exhibit to such a trial a
will prove and show its qualities. The judge
will be directed to take into consideration th
following points, viz.:—Efficiency, simplicit
of construction, durability, workmanship, eco
nomy in cost, economy in use, facility fo
repairs, facility of transport, percentage o
moisture removed, quality of fruit and vege
tables after drying.

I trust the result may be a new departure i
this country in the matter of fruit and vegetabl

ying, and that great help may be given to development of increased interest in an lustry likely to be of national benefit and pable of great extension.

Specimens of Dried Fruits and Herbs were iibited by Mr. W. Trotter, of Ledbury, and dried its—chiefly foreign—by Messrs. Hanson, Son, and rter, of Botolph-lane.]

DISCUSSION.

Captain **Addison Smith** said the ground had en so completely covered by Mr. Badger, that re was hardly anything left for him to say, but he ould be pleased to answer any questions which ght be put. The following statistics, however, ght be interesting:—Commencing in 1871, with out the first shipments of any magnitude, Cali- nia shipped fresh deciduous fruits, 1,832,310 lbs., nned fruits, 182,090 lbs. The first shipments from lifornia of any consequence of dried fruit were in 75, namely, 548,227 lbs. Shipments of deciduous its, in one form and another continued to increase nually until 1893, when the position as between nned and dried fruit changed, and while the amount fresh fruit decreased, the amount of dried fruit reased, which it has continued to do ever since. 1893, the shipments stood as follows:—Fresh its, 159,905,000 lbs., as against 1,832,310 lbs. in 71; dried or evaporated fruit 82,486,000 lbs. as ainst 548,227 lbs., in 1875; canned fruit, 58,681,400 ., as against 182,090 lbs. in 1875. Here the dried it shows, proportionately, a gain on canned goods, d continues to gain until our last report by the airman of the State Board of Horticulture to the ate Board of Trade, which gives the following ipments for 1895:—Fresh fruits, 132,508,000 lbs., against 159,905,000 lbs. in 1893; dried fruits, 2,652,000 lbs. as against 82,486,000 lbs. in 1893; nned fruits, 62,590,000 lbs., as against 58,681,000 s, in 1893. This shows that, since 1893, each class s changed its position, the shipments of fresh its have fallen off nearly 20 per cent., dried fruits ve increased 40 per cent., and canned fruits have ly increased 6 per cent.; while new fruit areas came to bearing in 1895, the crop was materially reduced frost in some sections; however, the fact remains that aporated or dried fruits have steadily gained favour the markets of the world. The shipments of fresh its in 1896 may exceed those of 1895, but he con- dered it safe to say that the shipments of dried fruits ill show a further, indeed a far greater, increase over 95. Canned and bottled goods will always take a rtain quota, but the best and most wholesome fruit oduct is the desiccated product. To show what e evaporator and canner have done for fruit grow- g countries, he would submit the following figures. 1871, in California, before the evaporator was troduced, the value of deciduous orchard products as £10,240, but in 1895 the value was £3,334,152.

Mr. A. **Ludwig** said the process had been very well described in the paper. In Germany it was just the same as in America. He was sorry to say that as yet the evaporator was very little used in England, only about 20 machines having been sold. Mr. Trotter was the first who had a machine, in 1891, and he worked out the process for himself. There was really no special skill or education required, but since then a pamphlet had been drawn up which was given with the machines, giving all the necessary information as to its use. It had been very successful in America, and there could be no question that it would be equally useful here. He had been sounded several times by persons who proposed establishing experimental farms, but the scheme had always been dropped on account of expense. Of course a certain amount of capital was necessary for such an undertaking, and it was very difficult in this country to interest people in such a scheme.

Mr. T. **Dyke** said that, as one of the stewards of the Bath and West of England Society, he was very pleased to hear the announcement made with regard to the experiments at St. Albans next month; but he was sorry to say that, up to the previous day, the Secretary had not received a single entry, and he believed the day for closing was May 1st. He was appointed a steward of the fruit department, and he feared he should have very little to do.

Mr. **Sebastian Davis** said it would be interesting to know whether the air which passed through the machine was previously dried. He used very largely a somewhat similar apparatus, but for quite a different purpose, and evaporated at rather a low temperature; and it occurred to him that the lower the temperature the less would the flavour of the fruit be effected. In his own case the evaporation was greatly increased by using air pumps to exhaust the air to a considerable extent. He was inclined to think that warming the air before entering and exhausting it would be advantageous.

Mr. B. G. **Berry** said he rather doubted some of the figures given as to the values. When the market value was spoken of, he apprehended it meant what the evaporators hoped to make of their product; but he should be glad to know if those prices were actually realised. For example, it was stated that what would remain as waste—the core, peel, &c., of the apples—could be sold at £4 a ton; but, in a plentiful season, you could buy the apple itself for half that money; and he did not think the jam boiler would give £4 a ton for the skins and pips; which would probably be a waste product. As a considerable fruit grower he was interested in knowing how to make the most of these products, but when they were told that the fruit to be successfully operated on must be of the best, the reply naturally occurred to him that they always knew what to do with their best fruit, they could always get a price for it. What they wanted to know was how to make a decent price for the lower grades. With all Mr. Badger's ability, he had not given him a crumb of comfort as to the disposal of the second and third class fruit.

Mr. W. W. **Berry** said he had watched what had been done in this country, from a countryman's point of view, and had come there anxious to learn more. English fruit growers using an evaporator had not been very numerous, but he did not know one who had made a success of it. He knew one very patient, plodding, hard working fruit grower, who worked the machine for two years and then gave it up as a bad job; he sent it up to the Swanley Horticultural College, and he believed it was there in a lumber room to this day. The apparatus was probably of an out-of-date type—certainly not such as they had heard of that evening, and if Captain Smith had a fair chance offered him in this country, he would probably begin at the beginning and go right through to the end and make a good job of it; but those who had attempted it so far had certainly failed. The only persons he had heard of who made a success were Mr Trotter and one individual at Chiswick. Only the other night he urged the East Kent Chamber to give some attention to the matter; to read the article in the *Journal* of the Royal Agricultural Society; to go to the show and get all the information they could, and report to the Chamber, with a view of stirring up some interest in the matter, and getting some co-operative system established, and a start made with the best machine that could be got. But he was met by such remarks as this:—"Oh, so-and-so has been trying it for so long, and has given it up, and so-and-so the same; there is nothing in it." Under such circumstances it was very difficult to get a number of people to join together and subscribe funds to start a thing of this kind. He was interested in a jam making business in the country which had been running eight or nine years, but it had not been successful, and they had now stopped it, and were waiting to see what would turn up. If the numerous makers would re-arrange their price lists there country factories might go to work again, and it appeared to him there would be a grand opening there for the evaporating business. If any gentlemen would find the capital they would find every assistance in the country to carry out such a scheme; but it was no use going into the country for the capital. The fruit was there, or soon would be, but there was very little money. There were many districts in which good buildings would be fouud, and every opportunity for making a really good start with this business. The reason fruit-boiling in the country had not succeeded was this. There were the numerous established firms, such as Crosse and Blackwell, Lazenby, Burgess, and others, who for many years past had done the business; then during the last ten or fifteen years, scores of country firms had cropped up and started boiling fruit themselves, because they could not get a remunerative price from these old firms, and imm diately fresh price lists were published and scores travellers were put on the road, and all were und selling each other in order to get the business. S went on until the little people were crushed out, a the big people had made hardly any money for seve years. If they started evaporators all over country, the same thing would go on if they w not careful. He for one should be very glad encourage any gentleman who wished to make start in his part of the country, and he had frien in several other districts who would do the same.

Sir **Henry Trueman Wood** said he and some his friends were interested in an estate in Mexi where, at all events experimentally, a certain amou of fruit was grown; and they made it their busin to inquire into the manner in which fruit was dried California and the United States. He really thoug Mr. Badger had hardly laid sufficient stress on t fact that the work was done in a much more efficie manner by these evaporators than in the old fashi of drying in the sun. The information he was ab to get was but superficial; but he thought one poi was worth emphasising; whatever else might lacking in South California, there was abundance dry air and hot sunshine; and if in a country whic above all others, was suited for natural drying by th sun, artificial dryers were found to work more sati factorily, surely they must be more efficient in country like England, where the supply of sunshi was so limited, provided, of course, the fruit was the same quality. He had heard it said that Englis fruit did not get sufficient sun to give it the capa bility of drying well. Why that was so he did n know, perhaps someone might be able to explain it— if it were really the fact. He might remark, that a vegetable products were not suited to this method drying. Experiments had been made in dryin coffee artificially, but, up to the present, he wa informed, they had all failed. He had recently ha the opportunity of going over one of the largest coffe plantations in Jamaica. There the coffee was a dried in the sun, on large terraces or floors. As th coffee lands were most of them at a moderat altitude, they were liable to sudden showers o rain, and it was necessary, in consequence, t keep a large number of hands ready and waiting to sweep the coffee off the terraces into covere sheds directly there was the least sign of rain. That, of course, involved considerable expense, as these people were doing nothing while they were watching, and many attempts had been made to dry the coffee artificially but he was told without success. At the Chicago Exhibition everyone must have been struck with the magnificent show of fruits, both fresh and dried, of which the Californian section was almost wholly made up; and it was an excellent illustration of the enormous extent to which dried fruits were used there. Those who had travelled in America lately knew, of course, that dried vegetables and its were there used to a much larger extent than re. With regard to the action of these machines, r. Badger had quoted the opinion of an American n of science to the effect that the successful action s due, to some extent, to the fact that the evapo- ion of moisture kept the fruit cool; but he did not ink the amount of evaporation which went on uld have much sensible effect in lowering the mperature of the fruit, and should rather be in- ned to attribute the difference in the effect of the aporators to the fact that the chemical changes ich went on in the presence of moisture when the it was heated, as in baking, did not go on when e moisture was removed. They knew that desic- ting animal or vegetable tissues had a very different fect to exposing them to heat in a moist condition. ith regard to the suggestion of a co-operating stem that had not been worked to any extent in y industry in England, but it might be worth con- dering whether it would not answer to take an aporator round fruit farms as thrashing machines ere taken round, drying the fruit on each man's own nd.

Mr. B. G. BERRY said he understood from Mr. adger that one very successful test was made with e Golden Noble, a Tasmanian apple. Now, all the ccessful Australian apples were of a very woody xture, with a much less percentage of juice than nglish apples. Not only did they produce a firmer oduct but there was much less waste in evaporation an with English fruit.

Mr. BADGER, in reply, said the prices he had men- oned were simply quoted from Mr. Pidgeon's article, d he had never heard them disputed; the only ult usually found with the figures was that the cost emed too great in proportion to the profit realised. et he was informed that a number of fruit evapo- tors in America were men of substance, and that ey had derived that substance from their business. s to the actual value of evaporation, as a method of ealing with fruit, he appealed simply to the fact at the Americans were as sharp and clear-headed any race on earth; that they knew when they had a od thing, and did not let many opportunities slip; d they used evaporators on a very large scale. He d not tried to talk tall, but simply to give such asons as would be likely to influence a sound judg- ent to move in the matter of introducing the system ere, if, after due consideration it was thought desir- ble. As to the price of £4 per ton for the refuse, thongh it was a long time ago, he thought Mr. idgeon spoke of a good deal of it being exported to rance and used in the manufacture of the commoner ass of wines, and Mr. Pidgeon was the last man to ive an over-coloured picture. With regard to the sing of only the best fruit, he meant the best kinds r evaporating, he did not mean only high class fruit hich was saleable in Covent Garden at the highest arket price. But it was no use attempting to make evaporated fruit out of material which would not cook. If you made pies of certain apples it was well-known they were uneatable, and you could not ask the evaporator to do more than a skilled cook could do with fresh fruit. The evaporator would take fruit you could not find a market for in the fresh state, and which you would have to give away or leave to rot on the ground, and enable you to make some money of it. If this were the proper time he could say a good deal about the proper varieties of fruit, for the choice of these lay at the very bottom of successful fruit growing. There were lots of old orchards filled with worn out fruit trees, many of them varieties which were of no use, when there were splendid varieties to replace them. All these should be eliminated, and their places occupied by the newest and best kinds, which were always saleable, if fruit was saleable at all. If the orchards were supplied with such trees, the farmer would be able to take the second grade fruit and make something of it. In answer to a further question, Mr. Badger said he had not any detailed information as to plums, but he would write to Mr. Trotter, and any information he obtained from him he would publish in the *Journal.*

The CHAIRMAN said there could be no doubt that Mr. Badger had done a real service in bringing forward this subject in the way he had. Many reasons could be given why it should be taken up and pressed on to its final issue, which he hoped would not be simply evaporation, to a large extent, in this country, but also in the colonies. If Tasmanian apples could be treated as successfully as had been stated, he had no doubt that the colonists there would be quite as capable as our American cousins of turning an honest penny in this way. That the method had been successful in England was shown by the specimens on the table, which had been sent by Mr. Trotter, which he invited the audience to inspect, as soon as they had passed a cordial vote of thanks to Mr. Badger, which he had much pleasure in moving.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

ROAD-CARRIAGE COMPETITION.

On the 5th of July last the proprietors of the *Engineer* announced that the sum of 1,000 guineas would be given by them, by way of prizes, for the encouragement of manufacturers and designers of horseless carriages. The Crystal Palace has been selected as the centre from which the vehicles competing for the prizes offered by the *Engineer* will start, and to which they will return at the end of their long run.

The chief conditions of competition are as follows, and to these conditions the following note is appended:—These are drawn up on the assumption that the present restrictive legislation will cease to be in force prior to the date of the competition, and that a new Act of Parliament will have been passed giving greater facilities. It may be, however, that this new Act will not allow of all the following conditions remaining exactly as now set forth, and they may possibly have, when the legislation is complete, to be modified. If, unfortunately, the state of the law should make it impossible, in the judgment of the proprietors of the *Engineer*, to hold the competition as present contemplated, no blame or responsibility shall attach to them or the judges, or to the Crystal Palace Company.

Classes.—The vehicles will be divided into four classes, and one supplemental class, in each of which a prize will be given, as follows:—

A.—For the best mechanically propelled vehicle constructed to carry—including the driver—four or more persons, the total weight, when fully loaded, not exceeding two tons, a prize of 350 guineas will be given.

B.—For the best mechanically propelled vehicle constructed to carry either one or two or three persons, the total weight, when fully loaded, not exceeding one ton, a prize of 250 guineas will be given.

C.—For the best mechanically propelled vehicle constructed to carry, in addition to the driver, not more than one ton of goods or parcels, the total weight, when fully loaded, not exceeding two tons, a prize of 250 guineas will be given.

D.—For the best mechanically propelled vehicle, constructed to carry, in addition to the driver, 5 cwt. of goods or parcels, the weight, when fully loaded, not exceeding one ton, a prize of 150 guineas will be given.

Supplemental.—For the vehicle, whether for passengers or goods, propelled solely by a motor actuated by the vapour of oil or spirit, having a lower specific gravity than 0·8, or a flashing point lower than 73° Fahr., Abel's test, and constructed to satisfy the requirements of any Act of Parliament, and the rules to be made thereunder for the time being respectively in force, which, in the opinion of the judges, best satisfies the purpose for which it is built, a prize of 100 guineas will be given.

The judges are to have the power to divide any prize in case of vehicles proving of equal merit.

Propelling Power.—Any method of propulsion other than muscular power, may be employed, provided it be contained in the vehicle.

Quality of Oil for Power Purposes.—Except in the supplemental class, no oil or other liquid used in any engine, whether for the production of an explosive mixture, vapour, or for fuel, shall have a lower specific gravity than 0·8, or a lower flashing point than 73° Fahr., Abel's test.

Entries.—Entries are to be made on printed f —to be obtained at the offices of the *Engineer* any time prior to 6 p.m. on the last day of July, 1 being forwarded by registered letter, addressed t Editor of the *Engineer*, 33, Norfolk-street, Str W.C., and accompanied by a deposit of £1 for entry; this deposit will be forfeited if the ve entered is not submitted for competition.

The competing vehicles must be delivered at Crystal Palace, Sydenham, between the hour 10 a.m. and 6 p.m. on some day prior to 2n October next.

Disqualification.—The judges reserve to themse the right of absolutely disqualifying any vehicl competitor from the competition for any infractio these rules, or for any cause whatsoever, and wit in any way being bound to state the reason or rea for which such disqualification is made.

Number of Vehicles to be Exhibited by each C petitor.—No competitor, either directly or by agent or otherwise, is to enter for competition similar vehicles in any one of the classes ab referred to; and each vehicle is to be entered by more than one person, that is to say, in the nam one individual or firm.

The judges appointed are Sir Frederick Bramw Bart., F.R.S., Mr. J. A. F. Aspinall, chief engi to the Lancashire and Yorkshire Railway, and John Hopkinson, F.R.S. The decision of the jud expressed in writing on any point shall be final binding on all parties, and from such decision th shall be no appeal.

The full lists of Regulations was printed in number of the *Engineer* for April 17th, 1896.

SECONDARY EDUCATION.

A conference on Secondary Education, was h by invitation of the University, in the Senate Hou at Cambridge, on April 21st and 22nd. The Cou of the Society having been invited to send a rep sentative, the Secretary was delegated for that purp and he accordingly attended the conference.

The task of the conveners of the conference rendered somewhat difficult by the fact that Government Education Bill, and also the Bill for Registration of Teachers, had been brought in in interval between the announcement and the hold of the conference. The latter Bill, which is to a la extent founded on the recommendation of the Ro Commission on Secondary Education, deals v largely with that branch of the subject, and thou the Education Bill deals primarily with element schools, it yet contains much likely to have an imp tant bearing on Secondary Education.

The resolutions carried expressed general appro of the scheme proposed in the Report of the Ro Commission, and specified for distinct approval establishment of local authorities and a central thority for Secondary Education, while a spe ition emphasised the desirability of preserving xisting freedom, variety, and elasticity which cterises Secondary Education in this country.

ese resolutions, which comprised the first day's were carried without very much opposition, t from those who saw that the establishment of authorities might eventually lead to the disestab- ent of the School Boards and to the transference ir duties to the County Councils.

the second day the question of the Registration raining of Teachers occupied most of the time. irst resolution expressed the desire that teachers d be included both on the central and on the authority. The desirability of the formation of ister, and of taking steps for ensuring the pro- nal training of teachers was asserted, though not ut a certain amount of opposition. The final ition expressed the opinion of the conference efficient proprietary and private schools should e adequate recognition and protection.

will be seen that there was not much in the con- ce bearing on the work of the Society of Arts, e resolutions, dealing entirely with general prin- s, could not of course have been expected to touch a question of detail as examination.

THE SPANISH CORK INDUSTRY.

r Majesty's Consul at Barcelona says that San de Guixols and Palamos are the two places in onsular district from which cork is exported, he preparation of the bark is carried on in the of Palamos. The preparation of corks forms the e industry of this town. The cork is stripped the trees, steamed or boiled, and pressed into s, and then cut into stoppers, the shavings being cted and shipped, after being pressed into bales, se in the manufacture of linoleum. The machinery in cutting the cork comes for the greater part France, and in one large factory—the only one ed by steam and owned by a German firm—the nes and driving machines, as also the electric ing machinery, are of German manufacture, but of the cork-cutting machines are of English ufacture, and in this industry there is possibly an ing for British trade and enterprise, but only he personal attendance of capable men who rstand the business and come to seek for orders, get them from principals. In the town of na it is estimated that 198,000 acres are devoted e cultivation of cork trees, the amount of cork luced being estimated at about 20,000 tons, and value at about £1,610,000. Cork is the third in importance in the list of exports from Spain. nish custom-house statistics do not specify the tities which are exported to the different tries, and large quantities which appear in the ial figures as having been exported to France are ly *en route* for England and Germany, being shipped to those countries in the ports of Cette and Marseilles. Raw or unprepared Catalonian cork is not exported, as it requires to be worked in a special way, and the Catalans themselves appear to be the only workmen who are able to treat it properly. The prepared cork is largely exported to British markets, notably to those of London, Dublin, and Edinburgh. Calcutta and Bombay, Sydney and Melbourne, and Montreal and Quebec, also take considerable quantities.

General Notes.

Arts and Crafts Exhibition.—An Exhibition of the Arts and Crafts Exhibition Society will be held this year in the New Gallery, 121, Regent-street, London, from Monday, the 5th of October, to Saturday, the 5th of December, 1896. The Exhibition will consist of contemporary original work in decorative design and handicraft, such as—designs, cartoons, and working drawings; decorative painting; textiles and needlework; glass (except stained glass for which there is no suitable light); pottery; metal work; carving and modelling; plaster work; cabinet work; book decoration, printing, and binding; wall papers; leather work, and other kinds of work at the discretion of the committee. Inventions or mechanical contrivances are not, as such, admissible.

Wine and Cider Production in France.—The total area under vineyards in France last year was 4,367,000 acres, and this shows a falling off as compared with the year 1894, of 49,500 acres. The total production of wine amounted to 26,687,000 hectolitres (587,114,000 gallons). The acreage under vines has fallen off year by year. In 1885 it was 4,975,000 acres; in 1891, 4,407,000 acres. In 1892 and 1893 it showed a considerable increase, while in 1894 it fell to 4,415,000 acres, and, as mentioned above, in 1895 it was only 4,367,000 acres. The French *Bulletin de Statistique* explains this falling off by the fact that the want of resources has paralysed the efforts of viticulturists in many departments to reconstitute their vineyards. The production of wine was less abundant in 1895 than in 1894 — 587,000,000 gallons as compared with 859,000,000; while in 1893 it amounted to 1,100,000,000 gallons. The year 1893 was not only remarkable for its abundant wine harvest, but it was an excellent year also as regards the quality of the production. As regards the imports and exports of wines of all kinds, these have diminished very considerably since the application of the customs tariffs. From 1885 to 1892 the imports averaged 240,000,000 gallons, and the exports 50,000,000. In 1893 the imports fell to 132,000,000 gallons, and the exports to 34,000,000; in 1894 the figures were respectively 99,000,000 and 38,000,000 gallons; while in 1895 the imports amounted to 99,000,000, and the exports to 30,000,000 gallons. The production of wine from raisins amounted to 16,000,000 gallons, against 11,000,000 in 1894. The departments showing the greatest production were Herault, Aude, Pyrénées Orientales, Puy de Dome, Loire Inférieure, and Gard. The yield of cider in 1895 was 563,000,000 gallons—an increase of 220,000,000 over the year 1894. The departments producing the most cider are the following:—Manche, Ille et Vilaine, Calvados, Orne, Cotes du Nord, Morbihan, and Eure.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MAY 6.—"High Explosives and Smokeless Powders." By HUDSON MAXIM.

FOREIGN AND COLONIAL SECTION.

Tuesday Evening, at Eight o'clock, unless otherwise notified:—

MAY 5.—"Australia's Prospects in British Markets." By JAMES F. DOWLING. SIR SAUL SAMUEL, K.C.M.G., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.

LECTURE II.—MAY 4.—Caustic Soda and Bleaching Powder—Copper refining—Zinc.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 4 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Swinburne, "Applied Electro-Chemistry." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. S. B. L. Druce, "The Report of the Royal Commission on Agriculture."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, United Service Institution, Whitehall, S.W., 7½ p.m.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. E. J. Wall, "The Reproduction of Colour by Photography." 2. Messrs. Cross and Bevan, "Artificial Silk."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Kidd, "Evolution."

TUESDAY, MAY 5 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. James F. Dowling, "Australia's Prospects in British Markets."

Royal Institution, Albermarle-street, W., 3 p.m. Professor C. Vernon Boys, "Ripples in Air and on Water." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. G. A. Boulenger, "Little-known Batrachians f the Caucasus." 2. Mr. F. E. Beddard, (i.) "C tributions to the Anatomy of Picarian Bird (ii.) "The Pterylosis of the *Capitonidæ.*" 3. M. F. Woodward, "Contributions to the Stud Mammalian Dentition"—Part III., "The Teet certain Insectivora."

WEDNESDAY, MAY 6 ... SOCIETY OF ARTS, John-str Adelphi, W.C., 8 p.m. Mr. Hudson Ma "High Explosive and Smokeless Powders."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MAY 7...Royal, Burlington-house, W., 4½ p.m

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Marett Tims, "The Tooth-genesis of the Canid 2. Exhibitions:—(i) Mr. F. Enock, Lantern sli illustrative of "The Habits of the Tiger Be Cicindela campestris;" (ii) Mr. H. M. Bern "Preparations of the Hermaphrodite Glands Apus."

Chemical, Burlington-house, W., 8 p.m. 1. A. G. Perkin, "Luteolin II." 2. Prof. Herm Bablick and Mr. A. G. Perkin, "Morin." (Par 3. Ballot for Election of Fellows."

Society for the Encouragement of Fine Arts, 9, C duit-street, W., 8 p.m. Mr. Francis W. Kitch "Arts in China."

Royal Institution, Albemarle-street, W., 3 p.m. W. Gowland, "The Art of Working Metal Japan." (Lecture I.)

Civil and Mechanical Engineers, 45, Charing-cr S.W., 7 p.m. General Meeting.

Iron and Steel Institute, 25, Great George-str S.W., 10½ a.m. Annual Meeting. 1. Mr. J H. Darby, "Mond Gas as Applied to St Making." 2. Mr. B. J. Hall, "Hot B Stoves." 3. Mr. Perry F. Nursey, "The P duction of Metallic Bars of any Section Extrusion." 4. Mr. E. Metcalf Smith, " Treatment of Magnetic Iron Sand." 5. Mr. E. Walford, "The Making of the Middle Lias Ir stone of the Midlands."

FRIDAY, MAY 8...United Service Inst., Whitehall-yard, S. 3 p.m. Colonel W. J. Ault, "The Dearth Officers in the Volunteer Force."

Royal Institution, Albemarle-street, W., 8 p Weekly Meeting, 9 p.m. Professor Silva Thompson, "Electric Shadows and Lumin cence."

Iron and Steel Institute, 25, Great George-stre S.W., 10½ a.m. Annual Meeting (continued). Professor C. W. Roberts-Austen, "The Rate Diffusion of Carbon in Iron." 2. Mr. J. S. Benneville, "Some Alloys with Iron Carbide 3. Adjourned Discussion on Mr. H. M. Howe's, pa "The Hardening of Steel." 4. The Baron Ha Jüptner von Jonstorff, "The Introduction Standard Methods of Analysis." 5. Mr. Osmond, "Mr. Howe's Researches on the Hard ing of Steel."

Junior Engineering, Westminster Palace Hot S.W., 8 p.m. Messrs. A. Anstruther Thoms and G. C. Allingham, "Notes on Belgian Ele trical Engineering Practice."

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, MAY 9...Botanic, Inner Circle, Regent's-pa N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W.. 3 p. Mr. F. Corder, "Three Emotional Composers (Lecture I. Berlioz.)

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FRIDAY, MAY 8, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. JAMES SWINBURNE delivered the second cture of his course on "Applied Electrohemistry," on Monday evening, 4th inst.

The lectures will be published in the *Journal* ring the summer recess.

APPLIED ART SECTION.

Tuesday evening, May 5th, 1896; SIR SAUL MUEL, K.C.M.G., Vice-President of the ciety, in the chair. The paper read was Australia's Prospects in British Markets," JAMES F. DOWLING.

The paper will be published in the number of e *Journal* for the 29th inst.

roceedings of the Society.

TWENTIETH ORDINARY MEETING.

Wednesday, May 6, 1896; SIR STEUART LVIN BAYLEY, K.C.S.I., C.I.E., Member of uncil, in the chair.

The following candidates were proposed for ction as members of the Society:—

ya, V. Nagam, B.A., Settlement Dewan Peishcar, Travancore, South India.
ardman, James, 88, King-street, Manchester.
bs, Edward Mitchell, 15, St. James's-row, Sheffield.
ff, James Arthur, London Pottery, Lambeth, S.E.

The following candidates were balloted for d duly elected members of the Society:—

ndell, W. Arundell Tagg, Shillong, Assam.
wford, Henry Fawcett, Engineer's Office, Cavan, reland.
ncock, Ernest Albert, Government Laboratory, t. Kitts, West Indies.
Learoyd, Samuel, Sherwood-house, Huddersfield.
Robertson, Surgeon-Major Sir George Scott, K.C.S.I., M.R.C.S., British Agency, Gilgit, Kashmir.
Ruttan, Henry Norlande, City Engineer, Winnipeg, Manitoba, Canada.
Saunders, Hon. Henry John, M.L.C., St. George's-terrace, Perth, Western Australia.
Spindler, Henry Lewis, Port Elizabeth, Cape Colony, South Africa.
Wood, William, Exton-house, 173, Choumert-road, S.E.

The paper read was—

HIGH EXPLOSIVES AND SMOKELESS POWDERS.

By HUDSON MAXIM.

I first began the investigation of the subject of high explosives and smokeless powders in England, in 1889. Since that time I have built two powder mills in America, one for the manufacture of high explosives, the other for smokeless powders for ordnance. In connection with my other work on these lines, I conducted a large number of experiments for the Pneumatic Torpedo and Construction Company, of New York, formerly known as the Zalinski Dynamite Gun Company, looking to the production of a smokeless torpedo powder, that is, a powder for the purpose of throwing high explosives or aerial torpedoes from ordnance.

Owing to the shortness of range of the pneumatic guns, and to the expense, cumbersomeness, and vulnerability of the plant necessary to operate them, it was determined, if possible, to substitute powder for compressed air. How well we have succeeded with smokeless powder, and the special advantages smokeless powder has for the purpose, is one of the things which I shall try to explain this evening.

The Maxim Powder and Torpedo Company of New York has been organised to operate under my inventions and to carry on this work, the principal shareholders in this company being also the principal shareholders in th Pneumatic Torpedo and Construction Co pany.

I shall offer no apology for my responsibility for a system of hurling dynamite about the heads of an enemy entering our ports, or for my endeavours to get that system adopted here for a more efficient defence of the coast of England.

When we look at war in its true light, it is, in reality, the business of killing and maiming of neighbours, and the appropriation of their property. The art of war consists in the employment of means and instruments to accomplish this purpose with the minimum of risk, expenditure, and loss on the investment. The history of nations is the history of wars. The millennium of universal peace is yet far off. There will be need of guns just so long as one man has any use for another man's property, or until all nations shall unite in a common confederation, a universal family of mankind, bound to peace under laws made in the common interest, when shall be realised that ideal society, mentioned by Tennyson—

> "The parliament of man, the federation of the world."

At best war is cruelty—yet it is often a necessity, and once engaged in should be made as terrible and destructive as possible while it lasts, in order that it may be as brief as possible, thus minimising the evil in the aggregate.

The most deadly and destructive engines of war are the most humane, and those employed in the production and development of them may justly be looked upon as humanitarians. One of the best guarantees of peace is to be prepared to make a breach of it as undesirable as possible. In high explosives is to be found one of the most, if not *the* most destructive agency for offence and defence at the disposal of man, and the part to be played by high explosives in the warfare of the future will be revolutionary. How to dispose high explosives, especially in large masses, when and where they will do the most good, is a question, upon the proper solution of which will rest the fate of nations. With the present state of the art of disposal of high explosives in the form of submarine mines and dirigible torpedoes, you are already familiar; hence, in the few moments I have, I shall, in connection with a few remarks on smokeless powder, dwell particularly upon what may properly be termed aerial torpedoes—that is, shell of proper construction filled with high explosives and thrown from ordnance, a subject in itself of such magnitude that justice cannot possibly be done to it in so short a paper.

The value of systems of offence and defence in war depends upon the degree of their efficiency as compared with their expense. For coast defence that weapon is best which, at a given expense, will cover entrances to harbours over the greatest range, and be itself least exposed to the fire of an enemy. On
shipboard that weapon is best which, at
given cost, weight and exposure to the fire
the enemy, will be most efficient in
destruction of other vessels and of co
fortifications. All these requisites, I belie
are embodied in the system of throwing hi
explosives from ordnance with gunpowd
which I present to you this evening. T
nearest approach to it yet developed is
system of throwing high explosives by mea
of compressed air. But the shortness of ran
of pneumatic guns, the difficulty and expen
of protecting them, and the enormous plant
engines, boilers and air compressors necessa
are strong objections against their use
coast defence, while their cumbersomen
and vulnerability, together with the ab
objections, render their employment on sh
board entirely out of the question.

With the fifteen inch pneumatic guns n
in use, 500 lbs. of high explosive may
thrown a distance of about one mile; 200 l
about two miles. This is the maximum ran
Hence a man-of-war could lie just beyond
range of these guns and destroy the entire o
fit without being exposed in turn to the fire
the penumatic tubes. It is obvious, therefo
that a practical system of throwing aerial t
pedoes must have a range substantially eq
to that of high power guns opposed to it, a
the quantity of high explosives thrown must
sufficient to effect upon the target greater d
truction than can be effected by ordinary sh
thrown from high power guns.

The next nearest approach to the system
throwing high explosives, which I present, is
be found in that of mortars employed in co
defence at the present time. These morta
which are generally arranged in batteries
four, are not usually trained upon the target
be destroyed, but upon an area of the chan
through which the target must pass in enteri
the harbour. Considering the difficulty
securing great accuracy of fire with morta
and the comparatively small amount of w
the shell will do even when striking, in or
to safely cover any considerable area a
bring to bear upon an approaching fleet su
cient energy to account for much, it is necess
to employ a large number of mortars, all
which have to be protected from the fire of t
enemy.

The present United States coast mortars
of 12 inch calibre, and are 12 calibres lo
The travel of the shot through the bore is ab
9 feet. The cost of the mortars is about $18,0
to $20,000 apiece, and it is safe to estima

at the cost of protecting coast guns or mor-
rs is about equal to that of the weapons
emselves. The weight of shell used for
ercing the decks of a man-of-war, is about
000 lbs., and will carry from 75 to 100 lbs. of
plosives. Only 10 per cent. of the weight
rown, therefore, is explosive. In order to
any considerable damage, the shell, in fall-
g, must strike the deck of a man-of-war point
wn; its efficiency depending upon its pene-
ating power to pass through the ship's deck
d down through her bottom, upon the des-
uctive effects of its explosion within her
mpartments, or between decks, and upon the
rge pieces of shell thrown as missiles. A
ortar shell striking in the water beside a ship
es no particular damage, unless by chance
strikes very close to her sides and explodes
actly at the right point and depth. Such a
sult, however, is purely accidental and is not
be calculated upon.

The chief thing to be considered in an aerial
rpedo or high explosive shell, is the quantity
high explosive it will carry, and the charac-
r of the explosive should be such as to deve-
the greatest amount of energy for the
ace it occupies.

In order to insure the disruption of the un-
otected side of a man-of-war below the water
e, it is necessary to apply an explosive energy
at least 6,500 lbs. to the square inch. This
presents the crushing energy transmitted
rough 16 feet of water by the explosion of
0 lbs. of gun-cotton, or the energy trans-
tted through about 20 feet of water by the
plosion of 100 lbs. of nitro-gelatin. Now, as
e crushing energy exerted by an explosive
rough water against the wall of a ship de-
eases as the square of the distance from the
ssel, it requires the explosion of at least
0 lbs. of nitro-gelatin or an equivalent high
plosive within a distance of 50 feet to ensure
e destruction of a man-of-war, and such a
antity exploding within such distance may be
unted upon as practically certain to produce
e desired result.

It should be borne in mind that these figures
present distances through which destruction
ay, with certainty, be depended upon. The
rible force of concussion of 500 lbs. of high
plosive transmitted through water will open
ams in the hull of a man-of-war even from a
stance of 150 feet, and cause dangerous
aks. Some of us who have returned from a
y's outing with a string of fish sufficiently
ge to support our reputation as fishermen,
ve had opportunity to witness the deadly efficiency of a dynamite cartridge exploded under water.

These photographs on the wall show a type of gun designed for throwing high explosives by the employment of low pressures well kept up throughout the bore of the gun. This is attained through the use of the smokeless torpedo powder which I shall explain to you this evening, which is made to burn with a constantly increasing combustion surface, thereby securing a corresponding increased evolution of gases.

Through the use of this powder, which gives a low initial pressure, and keeps that pressure up throughout the bore of the gun, comparatively sensitive explosives may be thrown with perfect safety at very long range. Shells or containers with thin walls may be used, because the projectile is not started with sufficient velocity to require very strong and thick walls to stand the setback of the explosive they contain. On striking the target, such a shell does not depend upon its own walls to furnish missiles, for the force of the explosion will be such that the wood or iron work about the crater of its action will be utilised as missiles, and the effective zone of danger and destruction from the terrible concussion of a charge of (say) 500 lbs. of nitro-gelatin will be incomparably greater and more fatal than the danger zone due to the explosion of a thick-walled mortar shell containing a small charge, even when due account is taken for the efficiency of the latter's missiles.

The gun illustrated by these photographs may be made of any desired calibre. It consists of a single forged steel tube, and should have a thickness sufficient only to give it enough rigidity and weight to modify the force of its recoil and enable this to be more easily controlled. To withstand simply the pressures required to give the necessary velocities, a gun of even 20-inch calibre would require a thickness of only about 2 inches.

A 13-inch gun of this type, using a pressure of 5,000 to 7,000 lbs. to the square inch, will throw 250 lbs. of explosive gelatin a distance of about five miles; 450 lbs. over two miles. A 20-inch gun of this type, using similar pressures, and having a length of travel for the projectile of 25 feet, will throw 200 lbs. of explosives more than ten miles; 500 lbs. about seven miles; and 1,000 lbs. over five miles.

The large shell which you see standing here is made for a 4-inch gun. This illustrates in structure the shell to be employed, though the latter are much larger. The shell is fitted with a fuse adapted to explode when it shall have penetrated to any desired distance or depth below the surface of the water or within the deck of a ship. So uniform are the pressures and velocities attainable with this torpedo powder that it is only a question of training the gun upon the target located by the range finder anywhere within a circle of ten miles, to insure the complete destruction of any man-of-war which should dare to come within range. It is obvious that the gun may be so erected as to be fired at any desired angle of elevation or depression.

The building, erection, and protection of a gun of this type of sufficient calibre to guard any port against bombardment would cost much less than any other means of protection, and it would be far more efficient. In fact, the cheapness of the gun and mounting is a very strong argument in its favour.

It is obvious that this system of throwing high explosives is equally efficacious on shipboard against coast fortifications, and for the destruction of other vessels at sea.

It is not necessary that a high explosive shell should fall downward upon a ship's deck. Practically the same result is had if the shell is fired directly across the ship's deck and exploded upon striking any of her superstructure.

Fig. 1 will illustrate the action of a dynamite explosion adjacent to a firm, resisting body, such as the earth's surface or the deck of a ship. There is a well-known theory that the action of dynamite is downward. It is often noted that buildings adjacent to a dynamite explosion have their windows blown out from within, and in the direction of the explosion. In this figure I have endeavoured to illustrate the action of such an explosion. E represents an explosive body. If it were suspended in space, or within a body of uniform resistance, its action would be uniformly even in all directions, as inscribed by the circle, F; but, placed adjacent to the earth or other firm resisting body, as G H, its action is to throw the entire mass of explosive or weight of its gases upward into the air, and the greatest display of action above the earth is in the direction of the line, P. Now, to raise a weight of 500 lbs., whether the body be solid or gaseous, at the velocity of gases of explosion, requires an enormous energy, without taking into account the resistance of the air. The body of explosive, E, may be likened to a ball of perfect elasticity, caused to rebound from the earth, exerting downward a pressure equal to the force which raises it. Hence, force is exerted downward, to form the cra

Fig. 1.

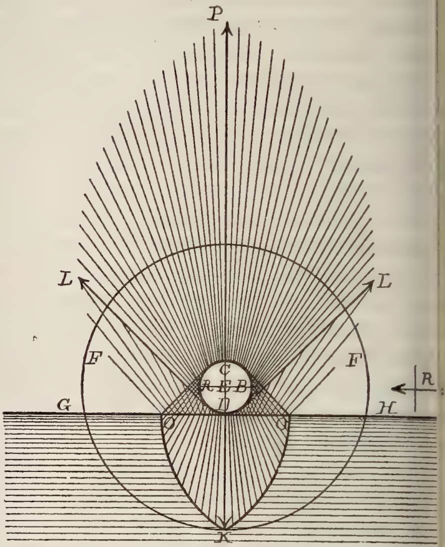


Illustration of Action of Explosion Adj cent to a Firm Resisting Body, as a Shi Deck or the Earth's Surface.

in the line, P, equal to the force exerted u ward, and which is sufficient to raise a weig

Fig. 2.

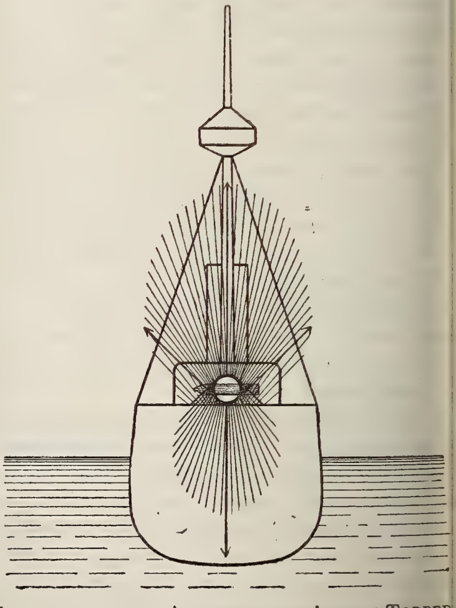


Illustration of Action of an Aerial Torped Over or Upon a Ship's Deck.

of 500 lbs. at a velocity of gases of explosior The action of the explosion being chiefly down vard and upward, a partial vacuum may be ormed, and an inflow of the surrounding air ccur in the direction of the arrow, K.

Fig. 2 illustrates the effect of the ex-xplosion of an aerial torpedo in its transit cross the deck of a man-of-war. The ex-losive, being tamped by its own weight, nd by the resistance of the surrounding ir, will re-act upon the ship's deck with destructive effect similar to that of a tor-edo exploded under water adjacent to a hip's side.

Fig. 3 illustrates the danger zone of a ship nder fire from one of these guns throwing a harge of 500 lbs. of high explosive, such as itro-gelatine. As this amount is sufficient to ink any man-of-war afloat when striking vithin 50 feet of her, and as it is necessary to it the vessel itself with the ordinary mortar shell in order to injure her, the danger zone, in favour of this gun throwing this charge, is more than quadruple that of the mortar, even though the mortar could be counted upon as certain to sink a ship upon hitting her, which is far from true. Whereas, with 500 lbs. of high explosive, to hit is to destroy. A 20-inch gun of this type will throw 1,000 lbs. of high explosive at a range equal to any coast mortar, and with far greater accuracy, thus still further increasing materially the zone of destruction. Furthermore, as the sea area within the range of these guns is more than three times that within the range of the mortar, and as the mortar cannot be trained and directed with anything like the same readiness and degree of accuracy, it appears to me that the efficiency of the two weapons as a means of coast defence is not to be compared.

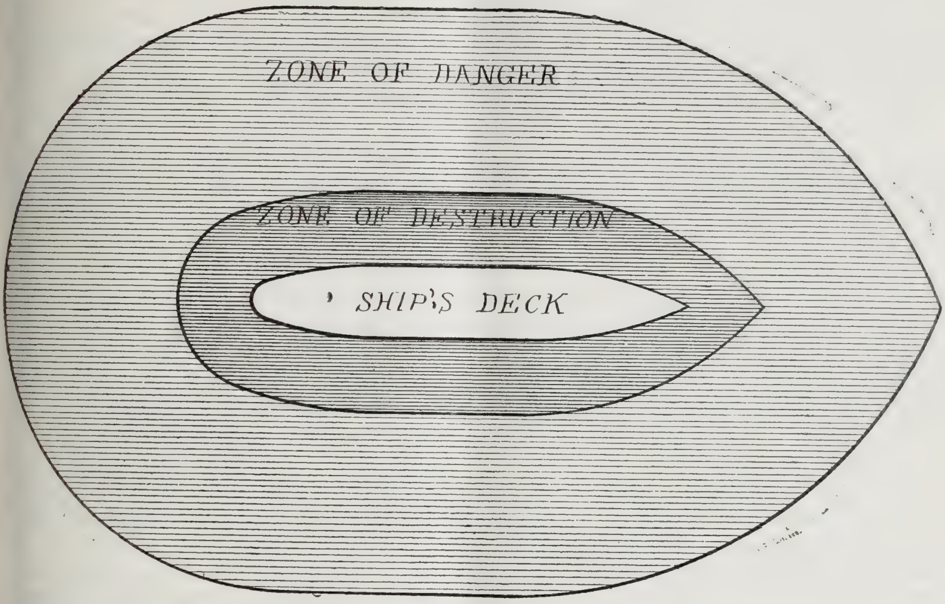


Fig. 3.

lustration of Zones of Proportionate Areas of Danger to a Ship under Fire from Aerial Torpedoes.

A New Smokeless Powder.

Several years ago, when smokeless powders ere first being introduced, and competitive sts were being made mainly between them d the old forms of black and brown powders, was easy to meet the ballistic requirements en imposed. Many changes, however, have ken place since then; the high ballistic sults attained by recent smokeless powders, gether with the knowledge gained from ex-rience as to the vital importance of securing permanent stability of the nitro-compounds entering into their composition, have tended to place the present standard of excellence for a smokeless powder very high indeed. To be considered satisfactory to-day, a smokeless powder must have earned a reputation for stability, based upon tests severe enough to place that quality above question, and it must give ballistic results that were once deemed impossible.

Experience in the use of smokeless powders has developed many things not at first anticipated, and the knowledge from which have been evolved the best powders of the present time, has been costly of attainment. Formerly the main object sought, was to secure high ballistic results. The importance of effect of the gases of combustion upon the bore of the gun was not understood, but as powders containing very large per-centages of nitro-glycerine were introduced, and many large and valuable pieces of ordnance were destroyed, the dangers arising from erosion were realised. At the present nothing less than a perfectly stable explosive compound, and one adaptable to guns of all sizes, and which will produce very high ballistic results, and work a minimum injury upon the gun, will satisfy Government authorities.

The Maxim powder consists of about 90 per cent. pyroxylin or gun-cotton, possessing a very high degree of nitration, with about 9 per cent. of nitro-glycerin and from half to 1 per cent. of urea. It is a true colloid, being perfectly amorphous or structureless, and exceedingly hard and horn-like. The powder, which is made in relatively long cylinders, is perforated axially with a large number of small holes, so that a minimum of burning surface is presented to the initial flame of combustion, and a comparatively low initial pressure is secured. As in burning the perforations increase in diameter, the combustion surface and consequent evolvement of gases is greatly extended, so that the pressure is well maintained throughout the bore of the gun, and a maximum of propulsive energy is secured to accelerate the velocity of the projectile.

The products of combustion of gun-cotton, or tri-nitro-cellulose, are well known to consist mainly of carbonic oxide. The Maxim powder consisting, preferably, of nine-tenths gun-cotton, its products of combustion contain but little carbonic acid. Gun-cotton alone does not contain oxygen enough in its composition to cause it to ignite and burn with sufficient readiness to constitute a practical cannon powder when made into a dense colloid. It is therefore necessary to add a quantity of some nitro-compound richer in oxygen. Consequently nitro-glycerin, which is very rich in oxygen, and resolvable completely into gases, has been found the most suitable smokeless oxygen-bearing element that can be employed. Gun-cotton powders made with an oxygen-bearing salt of a metallic base, such as nitrate of barium, are only a compromise between smoky and smokeless powders; from the explosion of such powders there remains a
smoke, and as deposit to foul the gun,
quantity of carbonate about equal to th
original amount of nitrate used, consequentl
such powders are but semi-smokeless.

The high velocities with comparatively lo
pressures that are obtained with smokeles
powders, containing a large per-centage
nitro-glycerin, are due to the large volume
gases and the enormous heat evolved by th
nitro-glycerin in combustion. This great hea
of combustion, in connection with the hig
specific heat of the gaseous water produced
and forming a large per-centage of the gase
gives the products of combustion of nitr
glycerin a tremendous expansive power abov
that of any other ingredient that can b
employed in a smokeless powder. This fac
coupled with the great increase in rapidity
combustion, as such a powder becomes heate
in burning, has given nitro-glycerin an exce
lent reputation as a constituent of smokeles
powders from a ballistic standpoint. Furthe
more, the ease and cheapness with which
colloid of gun-cotton containing large pe
centages of nitro-glycerin can be made, an
the great difficulty and increased expense i
making powders with a small per-centage
it, has caused nitro-glycerin to be used i
excessive quantities, which has to a conside
able degree counterbalanced the advantag
due to its high ballistic value. The product
of combustion of a smokeless powder contai
ing a large per-centage of nitro-glycerin hav
been found to be very erosive in their actio
on the bore of a gun. This is probably du
to the great heat, density, and richness i
oxygen of its gases. Such powders overhea
a gun very quickly, and consequently powd
containing a large per-centage of nitr
glycerin has the double disadvantage
greater density of gases and enormous
greater heat. At the temperature of explosio
of powder in a gun, the elements of wat
produced in the reaction of explosion are di
sociated, and exist as free hydrogen and fr
oxygen. Under the great heat and pressu
it is probable that the oxygen in the carboni
acid gas, as well as the free oxygen, attack
the surface of the bore of the gun, and change
the character of the metal in immediate co
tact with the heated gases.

In the early smokeless powders, especiall
those made of compounds of soluble pyroxyli
and nitro-glycerin, it was supposed that th
nitro-glycerin actually held and retained th
pyroxylin in solution, but it has since bee

oved that the nitro-glycerin is held by okeless powders, whether made with high low grade gun-cottons, in much the same nner as water is held by a sponge; in t, the pyroxylin exists in smokeless powder the shape of a very minute sponge-like sub- nce, within the pores of which the nitro- cerin is held in a free state. It is possible, en with powders containing as little as 25 per nt. of nitro-glycerin, to squeeze out the id in a pure state by subjecting a piece of powder to great pressure between two ooth steel plates. Moreover, nitro-glycerin s formerly supposed to be practically a non- latile substance, but it is now known that it aporates, though slowly, at all temperatures. l fine-grained smokeless explosives, such as le and shot-gun powders, containing per- ntages of nitro-glycerin, lose a considerable ight on long exposure, owing to its fine ate of division; and as the loss of a small r-centage of nitro-glycerin will greatly affect e ballistic results of smokeless powders, this a very important item to be considered. ith cannon powders, which are made in large ains or blocks, exposing a comparatively all surface for evaporation, the disadvan- ges due to this cause are reduced to a mini- um. The tendency to evaporate is also eatly reduced by lessening the per-centage nitro-glycerin employed. No objection can sustained, on this account, against cannon wders containing a low per-centage of nitro- ycerin.

You will observe by these Tables of results firing of Maxim powder at the Sandy Hook oving grounds in the United States, that the locities are remarkable for comparatively w pressures, when like charges are used.

STS OF SMOKELESS POWDER OF THE MAXIM POWDER AND TORPEDO COMPANY IN GUNS OF VARIOUS CALIBRES, AT SANDY HOOK, JUNE TO AUGUST, 1895.

TABLE I.—(5-*in. Breechloading Siege Rifle*).

Charge.	Projectile.	Velocity.	Pressure.
lbs.	lbs.	ft.-sec.	lbs.
6	45	1,544	14,100
9	45	2,219	27,345
9¾	45	2,403	30,600

Government requirements for this gun :—Velocity, 1,830 ot-seconds, with maximum pressure not greater than ,360 lbs. per square inch.

TABLE II.—(8-*in. Breechloading Rifle*).

Charge.	Projectile.	Velocity.	Pressure.
lbs.	lbs.	ft.-sec.	lbs.
55	300	1,977	29,808
57	299	2,019	32,148

Government requirements for this gun :—Velocity, 2,000 foot-seconds, with maximum pressure not greater than 33,600 lbs. per square inch.

TABLE III.—(3·2-*in. Breechloading Field Gun*).

Charge.	Projectile.	Velocity.	Pressure.
lbs. ozs.	lbs. ozs.	ft.-sec.	lbs.
1 7¼	16 8	1,617	29,600
1 7¼	16 8	1,615	29,400
1 7¼	16 8	1,617	29,491
1 7¼	16 8	1,617	29,033
1 7¼	16 8	1,611	29,067

Government requirements :—1,450 foot-seconds veloocity; pressure not to exceed 30,000 lbs. per square inch; projectile, 16 lbs. 8 ozs.

TABLE IV.—(10-*in. Gun*).

Charge.	Projectile.	Velocity.	Pressure.
lbs.	lbs.	ft.-sec.	lbs.
100	565	1,737	19,509
128	571	2,211	34,506

Government requirements for brown prismatic powder for this gun are as follows :—Charge, 250 lbs.; projectile, 575 lbs.; velocity, 1,975 foot-seconds; pressure, 37,000 lbs. per square inch.

TABLE V.—(7-*in. Howitzer.*)

Charge.	Projectile.	Velocity.	Pressure.
lbs.	lbs.	ft.-sec.	lbs.
2½	105	700	7,000
3¾	105	914	less than 14,000
4½	105	1,059	14,200
4¾	105	1,059	15,500
4¾	105	1,102	15,212
4¾	105	1,102	15,077
4¾	105	1,089	14,200
4¾	125	1,040	16,000
4¾	125	1,044	16,069
5	125	1,074	17,629
5	125	1,076	17,619

Government requirements for this gun :—1,060 foot-seconds, with 125 lbs. projectile. Pressure not to exceed 26,880 lbs. per square inch.

TABLE VI.—12-*in. Sea-Coast Gun.*

Charge.	Projectile.	Velocity.	Pressure.
lbs.	lbs.	ft.-sec.	lbs.
130	1,004	1,542	15,285
..	..	..	15,737
174	1,002	1,847	22,000
200	1,002	2,047	28,700
220	1,002	2,204	36,000

The results were obtained with the first samples of the powder tried in the respective guns, without any preliminary firing, to determine the best forms adapted to different calibres. These velocities were obtained with the shorter guns of the army; and higher results are reasonably to be expected in the longer naval guns. In examining these very interesting Tables, it must be remembered that the Maxim smokeless powder contains only 9 per cent. of nitro-glycerin; and that the only ballistic results heretofore obtained that are comparable with these results have been secured by the use of smokeless powders containing from 50 to 70 per cent. of nitro-glycerine. Probably the most remarkable result obtained with the Maxim powder is that with the 5-inch breech-loading siege gun. The Government requirements for this gun were a velocity of 1,830 foot-seconds, with a maximum pressure of 31,360 lbs. per square inch. The Maxim powder gave a velocity of 2,403 foot-seconds, with a pressure of only 30,600 lbs., or less than $13\frac{7}{10}$ tons. This beat the Government requirements about 5 to 3. The 7 inch Howitzer gave a velocity equal to the Government requirement, with a pressure of little more than half of that officially allowed for producing it. The results of firing the 3·2 inch gun are also very interesting; they were the outcome of some experiments made with the powder chamber shortened by a plug in the breech, and with every cubic inch of space in the powder chamber filled with powder. It was not sought to obtain a pressure less than 30,000 lbs., nor a velocity greater than 1,450 foot-seconds. With such density of loading the velocities for the pressures are very good, and the uniformity in both velocities and pressures is remarkable.

The difficulties hitherto encountered in the manufacture of a smokeless powder for large guns in the form of a colloid, consisting chiefly of gun-cotton of the highest degree of nitration, known as tri-nitro-cellulose, hav been removed by our processes; and the hig ballistic results, heretofore thought obtainabl only with a compound containing from 50 t 70 per cent. of nitro-glycerin, have bee exceeded by a compound containing onl 9 per cent. of nitro-glycerin.

DISCUSSION.

Mr. W. F. **Reid** said the experiment just exhibite seemed to show that the ordinary black powder ha much more energy in the free state than the smok less powder, though the latter was more powerf when confined. He should like to ask whether th fuses employed were time or contact fuses, an whether striking the water was sufficient to detona then? Also, if the results shown in the Tables we obtained by projecting shells with smokeless powd from the gun described? That was a point of co siderable interest, as hitherto it had not been accom plished. He had just been looking at the last numb of the *Scientific American*, which contained an illu tration of another dynamite gun, not Mr. Maxim's and an account of some experiments with it, whic were described as having been particularly successf in projecting dynamite shells; but one of the illustr tions showed the gun blown to pieces, and th explanation given was, that one of the shells ha accidentally exploded in the bore of the gun. Th would be rather awkward for those using it. H wished Mr. Maxim every success in introducing the death-dealing weapons to the English service; for we could keep a hostile fleet off the shores England so cheaply it would be much to our advantag But he feared Mr. Maxim would meet with co siderable difficulties with the authorities, and as a fello inventor, he might tell him something which occurre to himself. Being the inventor of a smokele powder, known as the E.C. powder, which ha obtained some reputation, he took a sample in 18 to Waltham Abbey to be tested. When he went hear the result, he was told that the velocity w much greater than that of black powder, but it cou never be introduced into the service for one reason for no other: that it would entail an alteration of th sights of all the rifles in the army. Since 1882 the had had to make greater alterations than that. H was bound to say that that was not the onl fault, but still, that was an instance of the wa in which an invention was looked at by one the most responsible officials; the details evident obscured the principal question. The French too it up, and when another nation started it, we ha to follow. The projectiles proposed to be use were an interesting example of atavism. In th beginning we had bolts from a crossbow, and arrows then we advanced to spherical projectiles, and now th most advanced inventors were coming back to the ol rm of the bolt, and the larger the projectile the longer was made. The main reason for this was no doubt at such a shape offered less resistance to the passage f a heavy body through the air. It was perfectly ue that in the case of a dynamite explosion panes of lass had been found blown out towards the explo- on, not from it; but he questioned if Mr. Maxim ad given the true explanation. He said it was aused by a vacuum; but how was the vacuum eated? He believed the true reason was that the ases were very highly heated during the explosion, ad immediately afterwards there was a condensation, d also an uprush of the large body of gases pro- uced, which caused an inrush towards the centre here the heat was generated. There were other rious points in connection with high explosives; ometimes a tall chimney would escape destruction hen all the buildings round about were levelled to e ground; that occurred at Stowmarket. He elieved that was due to a certain swing which had een given by the vibration of the air or the gases roduced, and unless the buildings got into the ving, which was a very short one, they did not go ver. He would ask Mr. Maxim whether the shape f the pellets was intentionally adopted on theo- tical principles or was simply one he found convenient r manufacture. In the case of the old black owder, they knew the surface of the grain was of reat importance in regulating the velocity of com- ustion, but it was not so to the same extent ith powders which contained sufficient oxygen in emselves for combustion. He thought the spherical rm was preferable, as you could regulate the amount gas produced in any given space, or at any given oment better than by any form of prism, and there as always the difficulty that however nicely it was acked, and however exactly the evolutions of gas as calculated theoretically, practically the prisms ways broke up during the explosion. With regard the erosion of guns by powders containing nitro- ycerin he believed that took place with all gases high pressures, especially when accompanied by increase of temperature. The sponge theory did ot accord with his experience at all. He had sub- cted compounds of nitro-cellulose, chiefly soluble, ith very varying proportions up to 50 per cent. of tro-glycerin to enormous pressures, and had never een able to get even a stain of nitro-glycerin out of em. When you went to higher proportions the se was different, and possibly with the insoluble riety there was greater difficulty in amalgamating e two substances; but he thought the nitro-glycerin ally did enter into combination with the nitro- llulose, and could not be squeezed or dissolved out. was pretty well known that nitro-glycerin was latile; workers in a dynamite factory knew that ey could not handle it, or even go into a room ith it, without getting a severe headache; and in a ely divided state it would evaporate, but in a ckage of powder the evaporation was almost *nil*, d if you had a pellet of any size, as the evaporation could only take place at the surface, the amount lost would hardly be appreciable.

Mr. McHardy asked if any tests had been made of the Maxim powder, to ascertain its capability for storage in various climates and at varying temperatures.

Mr. Maxim, in reply, explained the mechanism of the fuse, which consisted of a plunger of detonating material formed of 75 per cent. of fulminate of mercury, 15 per cent. nitro-glycerin, and 10 per cent. of gun-cotton, which formed a sort of leathery material, something like rubber. When lit in the air it did not detonate in small quantities, but when confined it detonated with great violence, the pressure being 27,000 lbs. per square centimetre. Outside this was placed dry gun-cotton, and pins were so arranged that when the projectiles' progress was retarded detonation took place. It was the joint invention of himself and Professor Alger, of the United States Navy, and had been experimented with to a considerable extent. It was found that the effect was much more forcible when the fuse was placed in the centre of the projectile rather than at either end. The Tables showed the results of actual firing with projectiles, the usual shell, under the usual circumstances. He was amused at the aptness of Mr. Reid's remarks about the difficulty of getting an invention adopted. One of the chiefs of the ordnance department objected to breech-loading firearms, on the ground that if the men ran out of cartridges, they would be in a very bad plight, whereas if they had powder at hand, they could load with pebbles or old nails, as they did at Bunker's Hill. But even there that plan did not work very well. The remark about atavism was interesting in more respects than one. In former times they kept putting on more and more armour, until finally they had to throw it all away, because it was found, as weapons increased in efficiency, it was better to have speed and mobility, and that the protection afforded by armour did not balance the inconvenience. They were coming to the same thing with armoured vessels. With regard to the effects of the explosion, he did not know that he differed from Mr. Reid. The vacuum, or partial vacuum, was caused exactly as he had explained. With regard to the shape of the powder, he could prove that the prisms did not break up, for he had several samples which had been partially burned, and which showed that the perforations enlarged. He considered the ideal shape was that adopted in the French B.N. powder—thin, flat slabs, which had this advantage, that the area was hardly at all decreased as it burned, the sides remained the same, and only the sides and ends diminished; such flat pieces, perforated transversely, were, therefore, the ideal shape. The cause of erosion was the pressure, heat, and density of the gases; and probably, also, the composition had something to do with it. He had fired smokeless powder, made with 56 per cent.

of nitro-glycerin, through two perforated discs of steel, and found the perforations enlarged from one-sixteenth to one-eighth of an inch, and the discs became fused together from the heat of the gases passing through. He had certainly found that, with a large per-centage of nitro-glycerin, there was more erosive action, even though vaseline, or something of the sort, was introduced into the powder. He did not know the reason, but probably the higher temperature had something to do with it. As the powder became heated up, it burned with enormous velocity; with some 65 per cent. nitro-glycerin powder made by other parties, and fired at Indian Head in the United States, one gun was expanded, and nearly burst about half way between the breech and the muzzle, the probable explanation being that the whole charge went forward and detonated. He had not had any great success in forming a compound of nitro-glycerin and gun-cotton. He had some pyroxylin very highly nitrated but perfectly soluble in nitro-glycerin, even at the ordinary temperature of the air, and on mixing it up, it would become nitro-gelatin, but on putting it between sheets of blotting-paper, the nitro-glycerin would come out and stain the paper; and on analysing it, he found it was pure nitro-glycerin, without a particle of pyroxylin. He also made a large quantity for the Brazilian Government, putting in 4 per cent. of camphor, exactly according to the Nobel formula, but as soon as it froze, the nitro-glycerin sweated out of it. With regard to evaporation, they dried the powder in a vacuum, and on opening the receiver, they had found, in the case of powder containing 50 per cent. of nitro-glycerin, that the nitro-glycerin was standing all round, just as water condensed on the outside of a jar containing ice. He had been informed of some experiments in Germany with a Nobel cube, which was put in a vacuum and left for two months, and the whole of the nitro-glycerin was found to be distilled out, leaving it in a perfectly spongy state. With regard to the stability of the powder, every precaution was taken to get the materials pure, and from ½ to 1 per cent. of urea was added. The effect of that was, that on heating the nitrous acid set free, was decomposed into carbonic acid, free nitrogen, and water, by combining with the urea. Some of this powder had been subjected to a heat of 212° for 5½ hours, and it showed no signs of injury. He had several samples which had been made to stand the ordinary Government tests, because urea being very expensive they did not put in more than was necessary.

The CHAIRMAN, in proposing a vote of thanks to Mr. Maxim, regretted that his place was not occupied by some one having more knowledge of the subject, but even to him the paper had been of intense interest. He could not help thinking that like the sun, which shone alike on the evil and the good, the Society of Arts, following the laws of nature wherever they led, cared little about the immmediate object, but followed the truth, whatever the resul might be. Almost the last meeting he attended that room was the one in which the Röntgen ra were demonstrated, and the lecturer then explaine the beneficial results in alleviating human sufferin which were likely to result from that discovery. T night they had heard of other scientific discoveries, t object of which was to show how we could torture an tear to pieces our fellow creatures, for the doctors wit their Röntgen rays to mend if they could. B he was convinced that Mr. Maxim was quite correc when he said that the more terrible and appalling th operations of war were made, and the more expensiv the less easy would it be for nations to make war, s that these discoveries did in reality make for peac and tended to bring about the ideal state of whic Tennyson spoke.

The vote of thanks was carried unanimously, an the meeting adjourned.

Miscellaneous.

AUSTRALIAN TOBACCO.

The *Bombay Gazette*, referring to Mr. Tripp' paper on the "Tobacco Industry of India," and th discussion thereon in the Indian Section, writes:—

"Australia threatens to compete with India as tobacco-producing country, and active measures ar now being taken, with a view to the development o this industry. Small quantities of tobacco have fo some time been grown, and the Melbourne Agricultural Department is of opinion that a highly profitable trade might be built up. With that object i view, therefore, the services of Mr. Bondurant, a American expert, were engaged, and he has just reported upon his inspection of the north-eastern districts of Victoria. In order to make the plantations there repay cultivation he declares that greate care in growing, curing, and grading are necessary. The curing sheds in Australian plantations are now open, whereas experienced manufacturers assert the absolute necessity for curing sheds to be enclosed on all sides. Mr. Bondurant has pointed out this to local cultivators, and has given instructions to the different settlers regarding curing, grading, and cultivation. Good may result from this. Mr. Bondurant makes two recommendations—first, that the suitability of soil and climate of particular districts for the different classes of tobacco should be carefully ascertained, because what would suit the soil and climate of one district would not suit another. He further recommends that small experimental stations be established in different parts of the colony for the purpose of making tests with the different varieties, nd when it is ascertained which thrives best in that istrict and gives the best results, there would be ore likelihood of growers being able to realise a rofit from its cultivation. He also suggests that, if rown lands cannot be obtained for the experiment, olders of land in the districts might find it to their dvantage to give a small site for the purpose. His cond suggestion is that at these stations there ould be model curing sheds erected, where object-ssons could be given to tobacco industry." The *ombay Gazette* urges the systematic improvement of e tobacco cultivation in India, and adds :—

Tobacco cultivation in India might be materially nproved and rendered more profitable were the gricultural Department temporarily to employ an pert who would point out the defects in the resent systems of cultivation and manufacture. rivate owners, we know, have engaged German pervisors in their factories, but they have been anufacturers rather than cultivators, and the defects the Indian cheroot lie in the leaf and not in the anner in which it is rolled. Indian cigar-makers ave deft fingers, and turn out a shapely well-finished gar. The material they have to work with is not good as it might be."

ORTICULTURAL SCHOOLS IN BELGIUM.

The Belgian Government has, for a long time, ntributed generously to the support of agricultural d horticultural science, which has become a national udy. There are two Government schools of riculture—one at Glembloux, the other at Hay. he United States Consul at Ghent says that two hools of horticulture likewise are under State anagement ; one of them is at Ghent and the other Vilvorde. In addition to these establishments ere are twenty-four agricultural schools under ivate management, but subsidised by the National overnment. They receive annual donations upon e condition of teaching the course of studies preribed by the State, and granting diplomas only ter an examination under supervision of the authoies. The schools are situated at La Louviere, euze, Dinant, Virton, Carlsbourg, Grammont, velghem, Deynze, Sotteghem, Waremme Hasselt, ecloo, Thielt, Ellezelles, Tessenderloo, Ninove, eauraing, Zelzacte, Alost Gyseghem, Lennick, St. uentin, Termonde, Iseghem, and Visé. Instrucon in agriculture is also given to girls and young omen of the peasant classes at the female instites situated at La Hulpe, Gyseghem, Virton, Isque, eule, Herve, and Brugelette. Instruction is also ven in the principles of agriculture in all the more portant garrisons, so that after his period of rvice the peasant youth may return home with a owledge sufficient to enable him to intelligently l the fields. The school of horticulture at Ghent as founded in 1849. The teaching staff consists of director and six professors. The course of instruction is entirely free to Belgians, but foreigners must pay a fee of about £7 per annum. The school is required by the State to combine theoretical and practical work ; the tone of its instruction is highly scientific. It aims to graduate learned horticulturists, and is particularly devoted to the cultivation of ornamental flowers and plants. The institution at Vilvorde, on the contrary, pays especial attention to the kitchen garden, and endeavours to educate practical workmen. The Ghent school makes a specialty of the cultivation of hybrids and of work in the laboratory. The chief plants cultivated and studied are palms, ferns, azaleas, and camellias. Arboriculture is taught to perfection. The course of instruction covers a period of three years. The examinations for admission take place during the first week in October, and the candidates must be 16 years of age. The subjects of examination are an excercise in writing and orthograghy, a simple composition, arithmetic (including the metric system), explanation of a printed extract, general geography, and national history. All the lectures at the school are given in the morning, and during the afternoon the students are divided into three sections. Each of these sections is occupied one week at a time in a horticultural establishment, in a nursery, and in the botanical garden, rotating throughout the year between these three places. A thoroughly practical instruction is thus imparted. Examinations for advancement from one class to another are held every August before a jury appointed by the Government. In addition to the regular course of instruction there are several annual series of lectures which are open to the public. For example for thirty-five years there have been given annually twelve to fifteen lectures on fruit tree arboriculture. These are delivered on Sundays in Flemish, especially for gardeners, and every Thursday they are repeated in French for the general public. For three years a course of lectures upon kitchen gardening has also been given. As regards the commercial relations of horticulture which have in recent years contributed so greatly to the prosperity of Ghent, the number of horticultural establishments in Ghent and its suburbs is 366. There are 2,535 hothouses, with 3,625,500 square feet of glass roofing. The total space occupied by cultivation amounts to 1,521 acres. There are about 20 very large establishments, and these have 70 to 72 hothouses each. Concerning the capital invested accurate statistics do not exist, but estimates vary from £800,000 to £3,000,000. The difference may be explained by a variation in the extent of territory comprised in these respective figures. Numerous societies exist throughout Belgium for the promotion of the interests of horticulture, the most important organisation of this kind being at Ghent—the Royal Society of Agriculture and Botany. There are altogether in Belgium 25 important, and 15 smaller societies of horticulture and botany. The total membership approximates 12,000. There are a dozen great floral exhibitions annually held in Belgium, and prizes amounting to £1,000 are yearly distributed. Finally, all these various societies are united in a national organisation known as the "Federation des Sociétés d'Horticulture de Belgique." This organisation holds annual conventions, and publishes a series of bulletins in the nature of reports of its proceedings. The first international congress of horticultural botany was held at the Brussels Exposition of 1864. In 1868 the meeting place was Ghent. These congresses are held regularly.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

MAY 13.—"Tunnelling by Compressed Air." By E. W. MOIR, M.Inst.C.E. JOHN WOLFE BARRY, C.B., F.R.S., M.Inst.C.E., in the chair.

MAY 20.—"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S.

INDIAN SECTION.

Thursday, at Half-past Four o'clock :—

MAY 14.—"Tea Planting in Darjeeling." By G. W. CHRISTISON. THE RIGHT HON. SIR RICHARD TEMPLE, BART., G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

MAY 12.—"Wood Engraving, as compared with other Reproductive Arts, and its Future as a Fine Art." By W. BISCOMBE GARDNER.

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.

LECTURE III.—MAY 11.—Aluminium—Sodium—Fused Electrolysis.

LECTURE IV.—MAY 18.—Calcium Carbide—Aluminium—Misceallaneous processes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 11... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Swinburne, "Applied Electro-Chemistry." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. R. M. D. Sanders's paper, "Landlord and Tenant in Ireland."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. William Wallace, "Through the Central Sudan to Sokoto." 2. Rev. Chas. H. Robinson, "Hausaland."

Medical, 11, Chandos-street, W., 8½ p.m. Annu Meeting.

TUESDAY, MAY 12... SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. (Applied Art Section Mr. W. Biscombe Gardner, "Wood Engraving a Compared with other Reproductive Arts, and i Future as a Fine Art."

Royal Institution, Albemarle-street, W., 3 p.m Professor C. Vernon Boys, "Ripples in Air an on Water." (Lecture II.)

Medical and Chirurgical, 20, Hanover-square, W 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m 1. Discussion on Mr. Jeremiah Head's pape "American and English Methods of Manufactur ing Steel Plates." 2. Mr. Samuel T. Wellman "Four American Rolling Mills."

Photographic, 12, Hanover-square, W., 8 p.m 1. Mr. H. Snowden Ward, "Dry Plates fo Röntgen Ray Photography." 2. Mr. Alfred Watkins, "Notes on the Pyro-developed Image." 3 Mr. J. B. B. Wellington, "A New Stripping Film for Negative Work."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1 Mr. H. W. Seton-Karr will Exhibit Stone Implements discovered by him in Somali-land." 2. Mr J. G. Garson, (i) "Recent Observations o the Andamanese by Mr. M. V. Portman;" (ii "Photographic Apparatus for Travellers." 3 Mr. R. J. Horton-Smith, "The Cranial Characteristics of the South Saxons compared with those o some of the other Races of Great Britain." 4 Heer C. M. Pleyte, "An Unpublished Batal Creation Legend."

Colonial Institute, Whitehall-rooms, Whitehall place, S.W., 8 p.m. The Hon. W. P. Reeves "The Fortunate Isles."

Asiatic, 22, Albemarle-street, W., 3 p.m.

WEDNESDAY, MAY 13...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Mr. E. W. Moir "Tunnelling by Compressed Air."

Geological, Burlington-house, W., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C. 3 p.m.

United Service Institute, Whitehall, S.W., 3½ p.m Lieut.-Colonel G. V. Fosbery, "Pistols."

Gas Engineers, 25, Great George street, S.W., 10 a.m. General Meeting.

THURSDAY, MAY 14...SOCIETY OF ARTS, John-street Adelphi, W.C., 4½ p.m. (Indian Section.) Mr G. W. Christison, "Tea Planting in Darjeeling."

Royal Institution, Albemarle-street, W., 3 p.m. Mr W. Gowland, "The Art of Working Metals in Japan." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W. 8 p.m. Messrs. Stanley Beeton, C. Perry Taylor, and J. M. Barr, "The Influence of the Shape o the Applied Potential Difference Wave on the Iron Losses in Transformers."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Gas Engineers, 25, Great George-street, S.W., 10½ a.m. General Meeting.

FRIDAY, MAY 15...United Service Inst., Whitehall-yard, S.W., 3½ p.m. Major C. B. Mayne, "The Difficulties of the Defensive."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Alexander Siemens, "Cable Laying in the Amazon River."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 16...Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Corder, "Three Emotional Composers." (Lecture II. Wagner.)

ournal of the Society of Arts.

No. 2,269. Vol. XLIV.

FRIDAY, MAY 15, 1896.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will be held at e South Kensington Museum (by permission the Lords of the Committee of Council on ducation), on Wednesday, 17th June.

Each Member will receive a card for himself, hich will not be transferable, and a card for a dy. In addition to this each Member will able to purchase additional tickets, the ice of which will be 5s. each up to the day of e *Conversazione*; on that day the price will raised to 7s. 6d. It is requested that Memrs requiring these additional tickets will ake early application for them. Every applition must be accompanied by a remittance.

Further particulars as to the musical and her arrangements will be published in the *urnal* later on.

CANTOR LECTURES.

On Monday evening, 11th inst., Mr. JAMES INBURNE delivered the third lecture of his urse on "Applied Electro-Chemistry,"

The lectures will be published in the *Journal* ring the summer recess.

APPLIED ART SECTION.

Tuesday evening, May 12th, 1896; SIR VEN ROBERTS, M.A., D.C.L., in the chair. e paper read was "Wood Engraving, as npared with other Reproductive Arts, and future as a Fine Art," by W. BISCOMBE RDNER.

he paper will be published in a later number he *Journal*.

FOTHERGILL PRIZE.

he Council of the Society of Arts offer the hergill prize of £25 and a silver medal for aper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society.

Papers submitted for the prize must be sent to the Secretary on or before 1st of October, 1896. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges no essay deserving the full award is sent in.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 13, 1896; JOHN WOLFE BARRY, C.B., F.R.S., M.Inst.C.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Firnberg, Max, 2, Lancaster-place, Belsize-park, N.W.
Ludwig, Frederick Augustus, 5A, Pall-mall East, S.W., and 16, Mincing-lane, E.C.
Perry, Charles Edward, Canadian Pacific Railway, New Denver, British Columbia.
St. Cyr, E. L. N., Aux Cayes, Hayti, West Indies.

The following candidates were balloted for and duly elected members of the Society:—

Gearing, Ernest, R.N.R., Penshurst, Clarence-drive, Harrogate.
Reeve, Henry, Anglo-French Boundary Commission, Upper Gambia.

The paper read was—

TUNNELLING BY COMPRESSED AIR.

By E. W. Moir, M.Inst.C.E.

Tunnelling operations are being carried on so extensively in London and other large cities, that I trust, a description of some of the latest developments may interest the members of the Society of Arts. The growing populations and the great distance to be traversed in our large cities demand some better and more rapid means of transit than is possible upon our already over-crowded streets. This end can only be attained by mechanical traction, which, as far as the country is concerned, is at present contrary to law upon the surface of the roads, except under restrictions which annul its advantages. There are, therefore, only two alternatives open to the engineer, viz., to make overhead railways, such as are at present in use in New York and Liverpool, along the public streets, or have them underground. The first suggestion would never be tolerated in any of the main thoroughfares of our large cities, and there remains but the second, or the making of the highways below the surface.

Our rivers, too, are such important highways of commerce that bridges, except at high levels, or with opening spans which obstruct both the river and the road, cannot be permitted. Here, again, the engineer is met with a limited choice—an opening bridge, a high level bridge, or a tunnel. Generally speaking, a tunnel, as it does not obstruct like an opening bridge, and permits easier gradients than a high level bridge, is to be preferred where impervious cover can be found, or where the maximum depth from the surface of the water to the bottom of the pervious strata does not exceed 85 feet, or a water pressure equivalent thereto.

I do not intend to go into the history of tunnelling from its commencement, which would occupy too much time, or even to describe those tunnels which are made either by blasting in rock or constructed, as are most of our railway tunnels, in comparatively dry material, with the aid of timber, which is ingeniously framed by the skilled miner to support the earth until the brick lining is placed within it. I shall confine my remarks to "shield-driven" tunnels, which date from the time of Brunel: that genius whose name will always stand among the greatest of our engineers.

In a patent dated 1818, Brunel proposed to make a shield-driven circular tunnel lined with cast-iron segments, the shield to be forced forward by hydraulic jacks abutting against the castings, which it overlapped and slid upon, as does the cap of the telescope slide upon the tube which forms the body. When he commenced his great work, the first Thames Tunnel, he did not, however, adopt this form, which, he states, he would prefer, for the reason, no doubt, that cast-iron was too expensive a material in those days; and even at the present time it is more expensive tha brick lining of equal strength. He therefo adopted bricks and mortar, making two tunne side by side, in a mass of brickwork. H shield was built of sections, which were mov forward by means of screws, which did n throw so much strain upon the new brickwo as would hydraulic jacks. Each section of t shield was moved forward separately, t material surrounding it being supported t while upon timber, which was held in place the two adjoining frames.

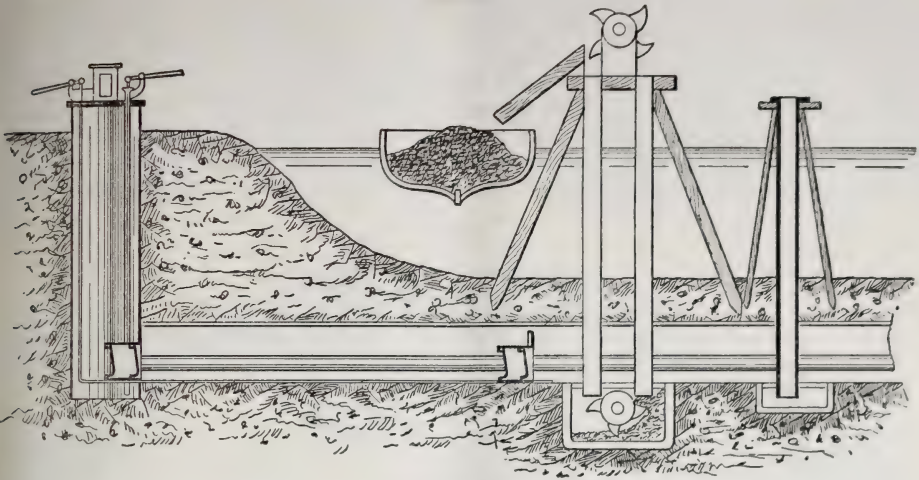
He met with and overcame immense diffic ties, financial and practical, and his work r mains to-day an engineering triumph, formi part of the East London Railway, an importa link connecting the north and south banks the Thames between Wapping and Roth hithe.

Brunel did not use compressed air, althou the idea seems to have been suggested to him Admiral Lord Cochrane (afterwards Earl of Du donald), who took out a most complete pate in 1830, covering its use in tunnelling in wate bearing strata. Brunel's tunnel, although success practically, was not so financially, a for a great number of years subaqueous tu nelling fell into disrepute.

The next attempt to tunnel the Thames and a successful one—was made in 1868, wh the Tower Subway was constructed, with M Peter Barlow engineer, and Mr. J. H. Gre head as contractor. It was a very sm tunnel, 6·7 feet in diameter, being for the u of foot passengers only; but it is remarkabl as being the first shield-driven, cast-iron lin tunnel. It was driven 1,350 feet throu London clay, and, including the sinking the shafts, was finished in less than 12 month reflecting great credit on all those connect with it. It is also of interest, as being t first tunnel in which cement grout was forc into the circular space between the lining a the larger excavated space formed by t shield. Six screw-jacks abutting against t completed cast-iron lining were used to pu the shield forward. No compressed air w required or used.

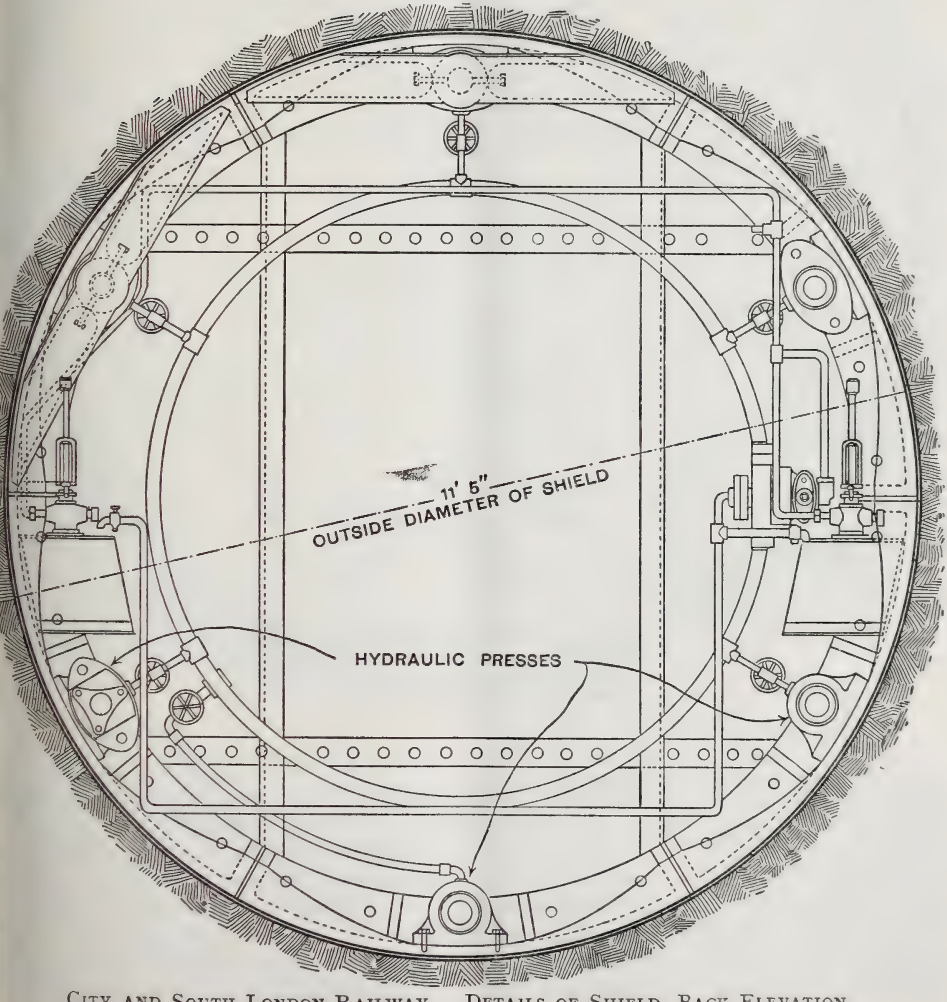
In 1870 a man named Beach constructed shield composed of timber and iron, and dro a small piece of tunnel under Broadway, New York City, and also in Cincinnati. T lining in this case was of brick, but the shie is the first in which hydraulic jacks were us to propel it forward. A hand pump w attached to the shield for the purpose; it of historic interest on this account.

FIG. 1.



LORD DUNDONALD'S AIR PRESSURE SYSTEM.

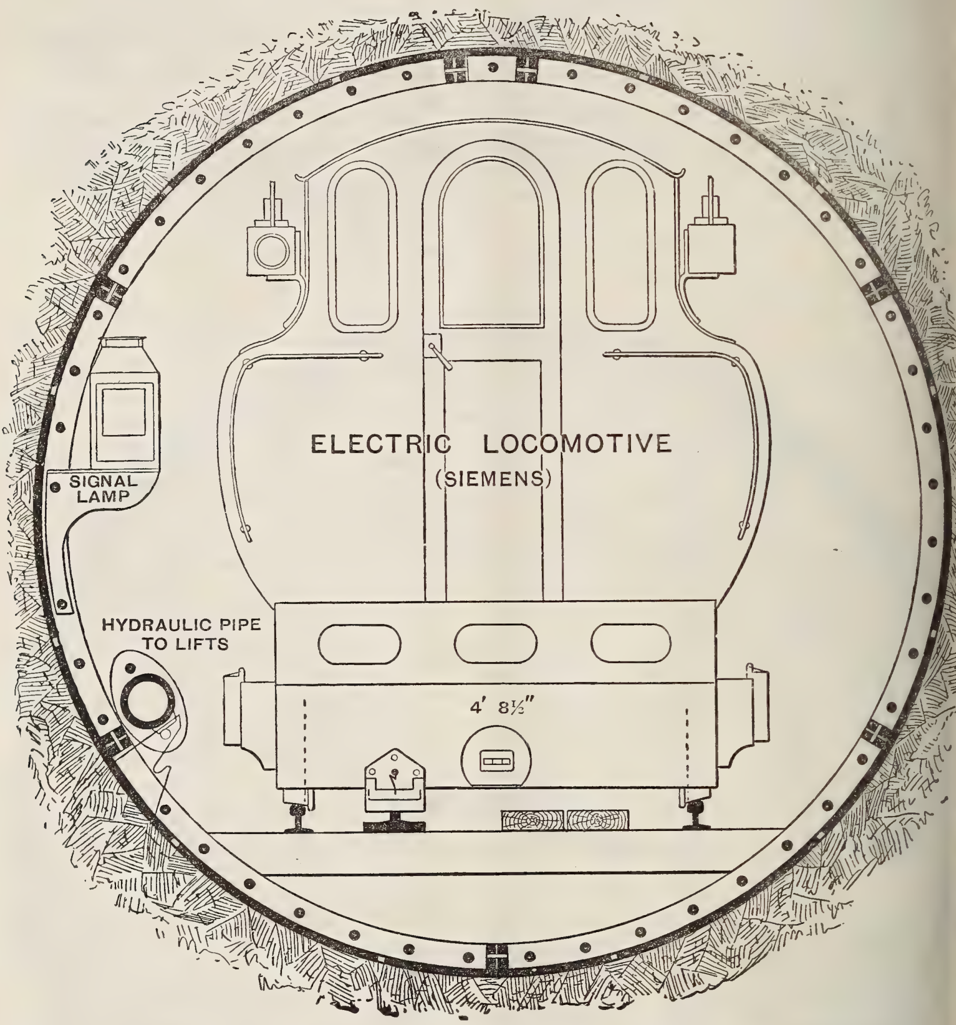
FIG. 2.



CITY AND SOUTH LONDON RAILWAY. DETAILS OF SHIELD, BACK ELEVATION.

In 1886, Mr. J. H. Greathead commenced his well-known City and South London Electric Railway scheme. It is the first undertaking in which a shield driven by hydraulic jacks was used in conjunction with compressed air for keeping out the water in pervious soil. The City and South London Railway starts at King William-street with two tunnels of 10 ft. 6 in. diameter, side by side. As they approach the Thames they gradually alter their positions until on reaching Swan-lane they are superimposed, the bottom of the upper being only a few feet from the top of the lower. This very unusual arrangement was adopted so that in passing under the narrow streets, both tunnel were under public property, thereby saving expense. The line ultimately terminates at Stockwell, a distance of about three miles of double tunnel in all.

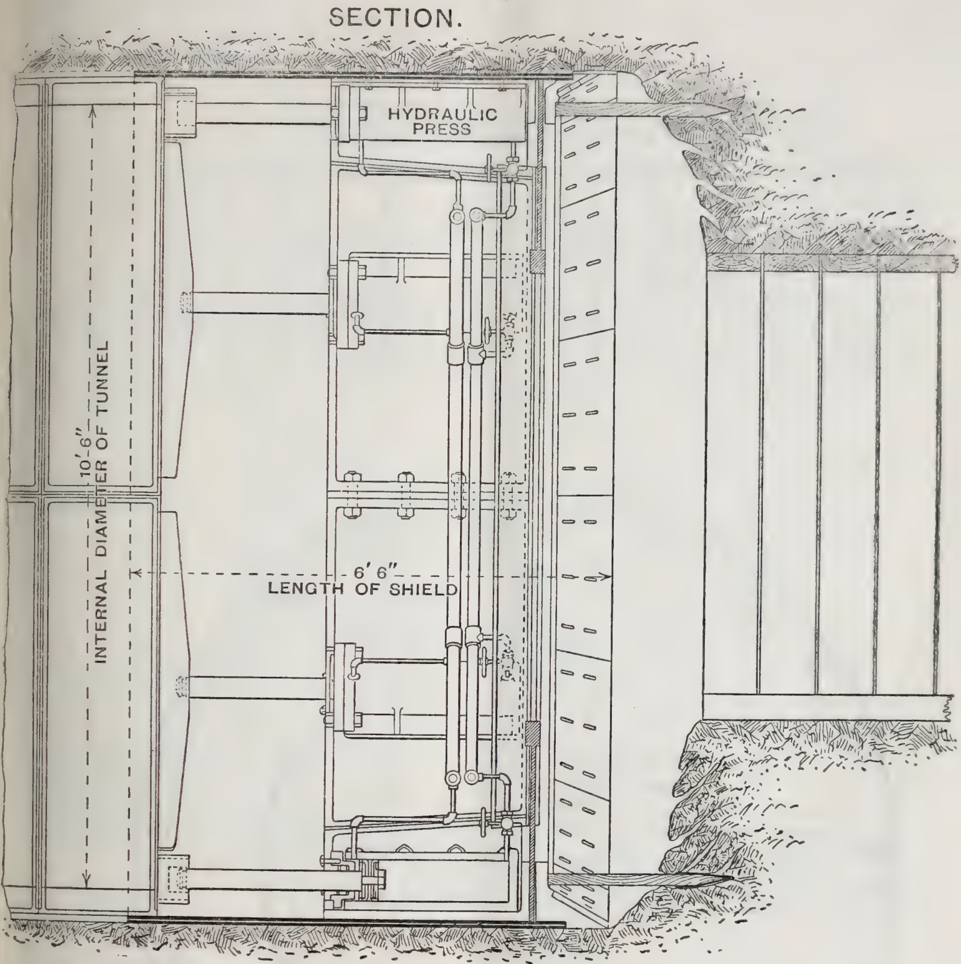
Fig. 3.



City and South London Railway. Cross Section of 10 ft. 6 in. Tunnel.

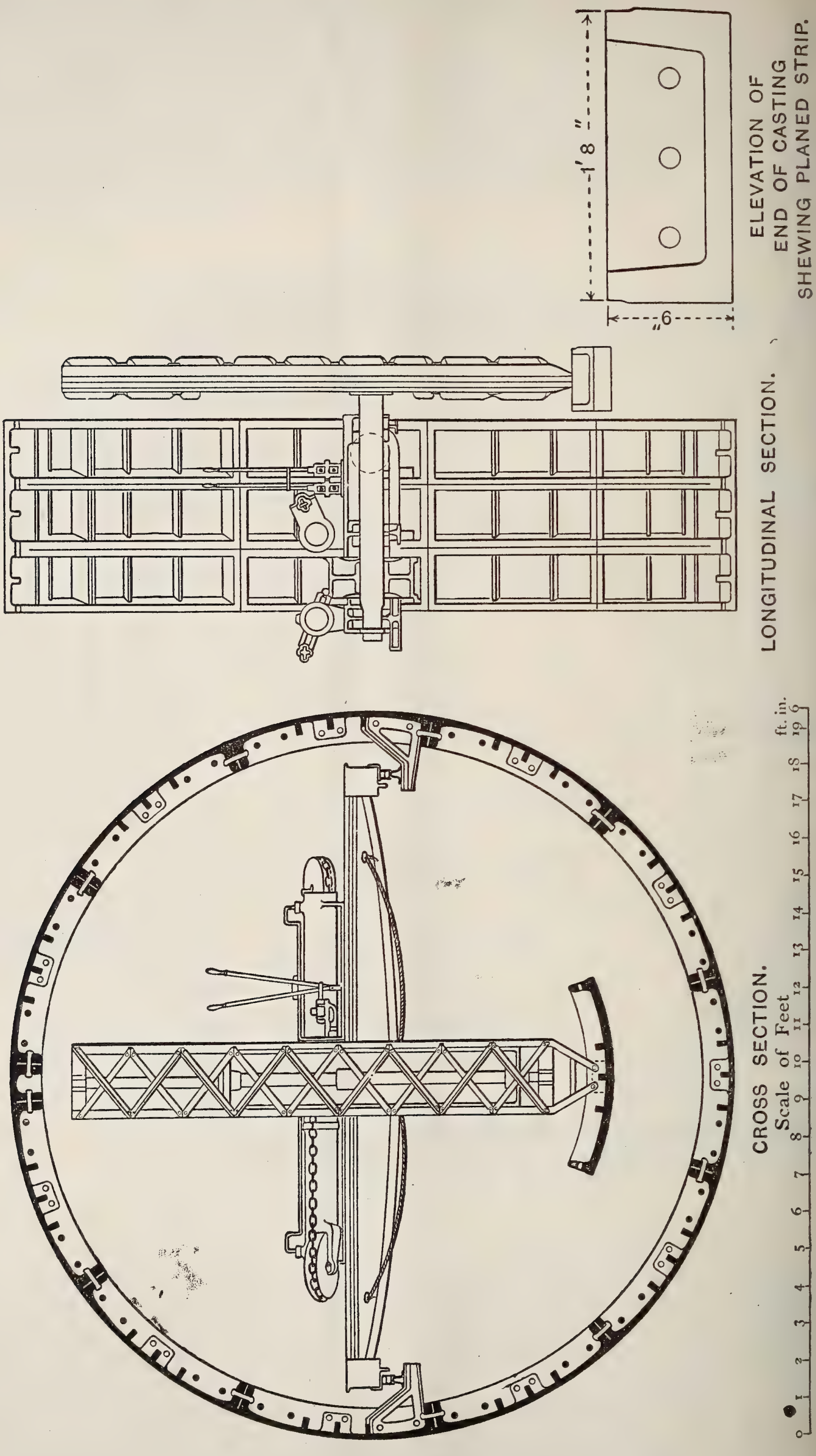
Under the Thames the two tunnels are in London clay all the way. No difficulties were met with and no compressed air was required. A bed of Thames gravel full of water was entered near Stockwell, and both tunnels were driven about 200 yards through it, pumping possible being inadmissible on account of th damage it would do to surrounding propert compressed air was resorted to with sati factory results although with increased e pense. The speed averaged 13 ft. 6 in. p day at each working face for months at a tim in the London clay. Progress was less rap when the ballast was entered, but even here the speed was between four and five feet, results unattainable in timbered tunnels. The shields used were 5 ft. 11 in. long, being composed of a strong cast-iron frame surrounded by a thin plate steel shell half inch thick in two layers. Adjustable steel cutters were fixed on the front end, and a working opening 6 ft. by 4 ft. 6 in. was provided in the centre of the shield, arranged so that in the case of necessity it could be closed with timber. Six hydraulic jacks, 6½ inches in diameter, were connected with a hand-driven pump attached to the shield for pushing it forward. A heading having been driven in advance of the shield, and the clay excavated roughly to its shape, it was pushed forward 20 inches at a time by means of the jacks. The rams were then drawn in by the same ump, and a cast-iron ring, composed of six egments and a keypiece, erected and bolted gether under the hood which overlapped the st completed ring, holding up the superincumbent earth. After the shield had been ushed, there remained an annular space surunding the castings which required filling up. ydraulic lime, which sets in a few minutes. as used, and was injected through holes cast in the plates for the purpose by Mr. Greathead's patent grouting apparatus, a drawing of which is on the wall. The lime was mixed with water to the consistency of thick cream, in a closed pan, and was stirred by revolving paddles until it commenced to get hot, when air at a pressure of about 50 lbs. per square inch was turned on to the pan and forced its contents between the clay and the lining,

Fig. 4.



City and South London Railway. Details of Shield.

Fig. 5.

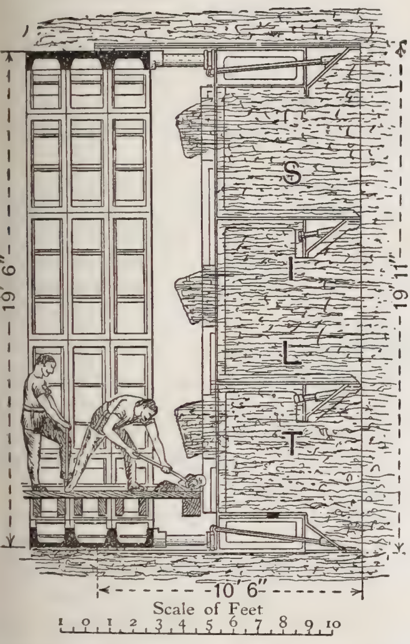


Hudson River Tunnel. Cast-Iron Lining and Erector.

where it set quite hard almost immediately. The castings being but light, were erected by the men without the aid of any special lifting appliance, such as is necessary in larger tunnels of the same class. They were an inch thick at the back, and had flanges 3½ inches deep. They weighed about 2¾ tons to the yard of tunnel. Sir John Fowler and Sir Benjamin Baker were the consulting engineers, and Messrs. Gabbott and Walter Scott and Company the contractors.

Two American examples of cast-iron lined shield-driven compressed air tunnels are the Hudson Tunnel in New York, and the St. Clair Tunnel, between the United States and Canada, under the St. Clair river. They are both of special interest, but time will only permit of a short notice of them.

Fig. 6.



Hudson River Tunnel. Vertical Section.

The Hudson Tunnel was commenced in 1879, nd is the first tunnel in which compressed ir was used, although, as already stated, it vas suggested by Admiral Lord Cochrane in 830. It is driven entirely through soft river ud or silt, so fluid that it will flow through a lit one-eighth of an inch wide for weeks gainst a pressure little less than the hydraulic ead.

About 2,000 feet were driven by means of ompressed air, and what is known as the ilot system of tunnelling, invented by Mr. Andersen, a Swede, and first applied in the Hudson Tunnel by him. It consists of a central, circular, iron-plated heading, about 6 feet in diameter, the forward end of which is in undisturbed ground, and the after end supported on the completed brick lining. From this tube timbers radiate to the outside of the excavation, which is held in place by thin steel plates carried as far as may be found necessary down the sides, which are built in behind the brickwork. Very good progress was made by this means, but as the tunnel was extended further under the water and approached nearer the river bed, the silt became more fluid, and the air pressure necessary to keep it back at the bottom was more than the reduced depth of mud above would stand, and several blow-outs occurred. It became necessary, therefore, to introduce the shield and cast-iron lined system to make further progress, and in 1889, on the recommendation of Sir John Fowler and Sir Benjamin Baker, and Mr. Greathead, Messrs. S. Pearson and Son were intrusted with a contract for carrying on the work, some fresh capital having been raised in England, and I represented them upon the works. The shield, which weighed about 80 tons, was put together 2,000 feet out from the Jersey shore of the river, under a pressure of over 35 lbs. per square inch above the atmosphere. It was a very difficult job, having to be rivetted up by unskilled men, but it was ultimately got to work, and made good progress until financial difficulties again beset the company. During the 12 months that the shield was working, however, nearly 1,900 feet were constructed under an air pressure of 30 lbs., and as much as 72 feet of completed tunnel were fixed in one week. Out of 5,500 feet in all, there only now remain some 1,600 feet to complete to make a connection between New York and Jersey City, and there is no doubt that money will be forthcoming some day to finish this work, which cannot fail to be an important connecting link between New York and the mainland, from whence nearly all the main western trunk lines start. The Hudson Tunnel is principally noticeable for the following facts, viz.:—Air pressure was here used for the first time in tunnelling by Haskin the promoter; the pilot system of tunnelling was introduced by Andersen; the tunnel was driven through river mud; a hydraulic erector was used for the erection of the cast-iron lining; and the principal cause discovered and a cure found for a large proportion of the cases of diseases due to compressed air among the workers.

The idea of reinforcing the river bed by clay was first suggested by the contractors to make the working more safe where there was little cover.

When I first went to New York the men had been dying at the rate of one man per month, out of 45 or 50 men employed, a death-rate of about 25 per cent. per annum. With a view to improving this state of things, an air compartment like a boiler was made in which the men could be treated homeopathically, or re-immersed in compressed air. It was erected near the top of the shaft, and when a man was overcome or paralysed, as I have seen them often, completely unconscious and unable to use their limbs; they were carried into the compartment and the air pressure raised to about half or two-thirds of that in which they had been working, with immediate improvement. The pressure was then lowered at the very slow rate of 1 lb. per minute, or even less, the time allowed for equalisation being from 25 to 30 minutes, and even in severe cases the men went away quite cured. No man ever suffers by going into compressed air, unless his eustachian tubes are blocked, which is the mechanical effect of the pressure being on one side of the ear drum only. This produces intense pain, and one must go out, unless relieved by swallowing or by holding the nose and blowing, thereby increasing the pressure in the throat and lungs. The medical lock should be used at once, as it does not appear to have much effect after some time time has elapsed. Such an appliance had never been used before it was introduced by us at the Hudson Tunnel.

It appears to me that when a man goes into compressed air he is in the same condition as a furnace under forced draught. Suddenly three or four times the weight of oxygen is passed over his lung surface, or through his furnace, the system gradually assimilates itself to that increased oxygen, and more combustion goes on. When he comes out, however, there is a sudden reduction in the amount of oxygen, the forced draught is shut off, as it were, and, as it is in the case of a furnace, there is a production of carbonic oxide, or an accumulation of carbon through an insufficiency of oxygen to burn it up. I think there is much the same effect in the case of compressed air. The carbon goes on accumulating in the blood, and after the man has come out he is actually poisoned by the effect of carbonic acid or carbonic oxide. This idea is partly confirmed by the fact that whenever the air is ever so slightly impure—much less than can safely be breathed and is breathed at ordinary atmospheric pressure—increased sickness i the consequence.

I have had the air analysed at the Blackwal Tunnel every week, and have found that i the amount of carbonic acid much exceed one part in a thousand an increase of sickness results. In mines, according to Professo Huxley, it averages nearly eight times thi amount. Fortunately there have been n deaths, but there have been some cases o paralysis which were immediately cured in th lock, and there have been a few cases o vertigo, one of which was more or less permanent, though the man is slowly recovering The great necessity is to have plenty of air and as the pressure increases purity must b greater. The bad effects of increase in th carbonic acid are most noticeable if there is sudden increase of pressure with impure air a the same time, for after a time the men' systems seem to get accustomed to the impurity Before I found out the above facts in Ne York, the air in analysis showed a muc higher per-centage than we have ever had a Blackwall.

The impurity never effects a man whil below, but only after he comes out, and w had mules working under pressure in Ne York for over twelve months at a stretc which sold at good figures after coming out Another idea of the cause of the diseas which occurs to me as possible is, that th blood under the increased air pressure actuall absorbs the carbonic acid, as does the wate in the manufacture of aërated waters, whic may bubble off when the man comes out an stop the circulation.

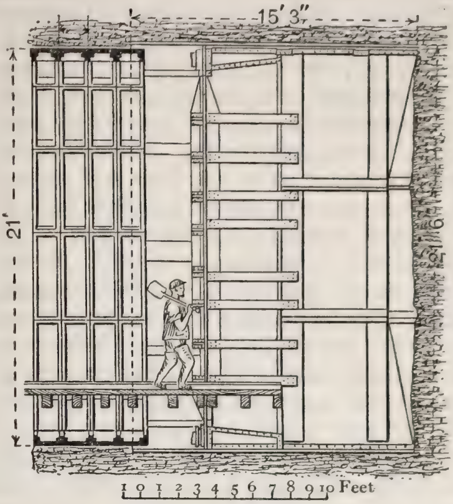
It seems probable that for high pressure i would be well to pass all the air, which usuall contains ·4 parts of carbonic acid per 1,00 on the earth's surface, before being sent dow to the men at all, through lime water, thereby taking from it all the carbonic acid it contains less air would then require to be pumped pe man.

I have seen a man's veins opened in Americ whose blood was so thick and black that it ha to be squeezed out, not being fluid enough t flow by itself. This man did not recover, an was one of the cases which I think would hav been cured by the lock if we had had it from the first. Every man should be medically examined and hot coffee should be given to each man before he comes out of compressed air; a warm room to dress in, and extra clothing for passage through the lock should be supplied.

By introducing the medical lock and the precautions as detailed the deaths at the Hudson Tunnel were reduced to only two in fifteen months with a squad of 120 men at work. At the Blackwall Tunnel, with the experience gained and attention to the above points, we have not had a single death, notwithstanding the fact that we had men working under a pressure of 37 lbs. per square inch for some time, while there have been deaths at the Glasgow tunnels at much less pressure quite recently. Generally sparely built men not too full blooded are those who stand air pressure best. A man who has weak lungs may work and improve, but one with a weak heart, or any apoplectic tendency, should not go in at all, or if he does only for a short period. Drink of all classes is bad, but such drinks as tend to thicken the blood are worse than spirits.

At the Hudson Tunnel the silt was so soft that we pushed the shield without attempting to do any mining in advance, and the material used to flow through the restricted area of the doors at ten times the speed of the advancing shield, when it was filled with waggons and run to tip. The pushing used to take from 10 to 20 minutes, and the ring was erected, as soon as the silt was removed by the hydraulic erector shown in the diagram.

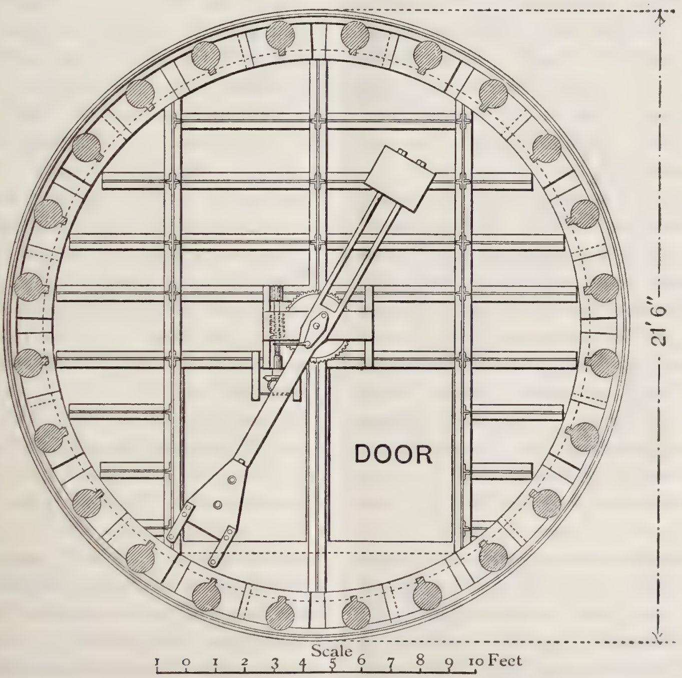
FIG. 7.



ST. CLAIR TUNNEL. VERTICAL SECTION.

The St. Clair Tunnel is a very successful completed example of a cast-iron lined tunnel, driven by means of shields aided by compressed air. The shields started—one in the United States and one in Canada—in July, 1889, and met under the river in August, 1890, the average speed throughout being about

FIG. 8.



ST. CLAIR TUNNEL. BACK ELEVATION OF SHIELD.

eight feet per day of completed tunnel at each face. The maximum done in one month by one shield was 382 feet. The material was soft, damp clay, partially fluid, which, before the introduction of air-pressure, used to force its way into the shield, necessitating the removal of a greater volume than its displacement. To prevent this, and to guard against an inrush of inflammable gas, air-pressure was introduced when the tunnels had reached the river banks. A trial heading had sometime before been driven out under the river, without the aid of air-pressure, several hundred feet, and abandoned, owing to the gas met with. The heading was timbered up at the end, and ultimately caused the only serious difficulty experienced. The bulk-head which was built across the end of the heading was forced along it by the fluid clay, causing a funnel-shaped opening through the clay to the ballast in the river bed, the hole formed together with a part of the heading was filled with the gravel, through which the compressed air escaped freely. The air-pressure was increased, while at this point to 35 lbs. per square inch, the gravel being smeared the while with wet clay to make it air tight. The air pressure was not generally that due to the hydrostatic head, being usually about 20lbs., the above pressure of 35 lbs. being the maximum at the time.

The outside diameter of the cast-iron lining was 21 feet, and the inside 19 ft. 10 in., the flanges being 7 inches deep, and the metal 2 inches thick at the back. The plates measured 18¼ inches along the tunnel, and there were thirteen of them, and a key-piece to each ring. The total weight of iron per foot of tunnel was 9,333 lbs.

The castings comprising the ring were erected by a revolving arm worked by hand, creosoted oak packings 3-16th inch thick were placed between the planed ends of the castings, canvas packings coated with some resinous compound being used between each ring.

The shields were 21 ft. 6 in. outside diameter by 15 ft. 3 in. long, the outer plating being 1 inch thick in two layers. They were divided into twelve compartments by cross girders 5 feet deep, commencing 2 feet within the cutting edges. A plate diaphragm 11 feet from the cutting edge, provided with two doors 6 feet and 4 ft. 6 in. at the bottom, extended across the shields, the doors being always kept ready to close should there be an inrush of water, this however never occurred. The shields were found to be too weak for the work, and had to be reinforced by timber diagonals in every pocket, some of the smaller spaces being entirely filled up with timber.

The clay was so soft, however, that this caused no inconvenience, simply flowing round the obstruction.

Twenty-four 8-inch hydraulic jacks forced the shield forward, being driven by a direct acting pumping engine. The pressure required to drive the shield varied from 450 to 2,000 American tons of 2,000 lbs. each. Two inches of clearance was allowed all round between the shield and the castings, which was filled up as the shield advanced by cement grout pumped in. The clay was so soft that it was possible to remove it by means of draw knives bent into a half hoop. This tool was introduced by a cooper, who, not being able to use a shovel, schemed this simple appliance, which was found so useful that it was adopted for all the men, and increased the rate of progress considerably.

Mr. Hobson, chief engineer of the Great Western Division of the Grand Trunk Railway, carried out this successful work, the original idea being due to Sir Henry Tyler.

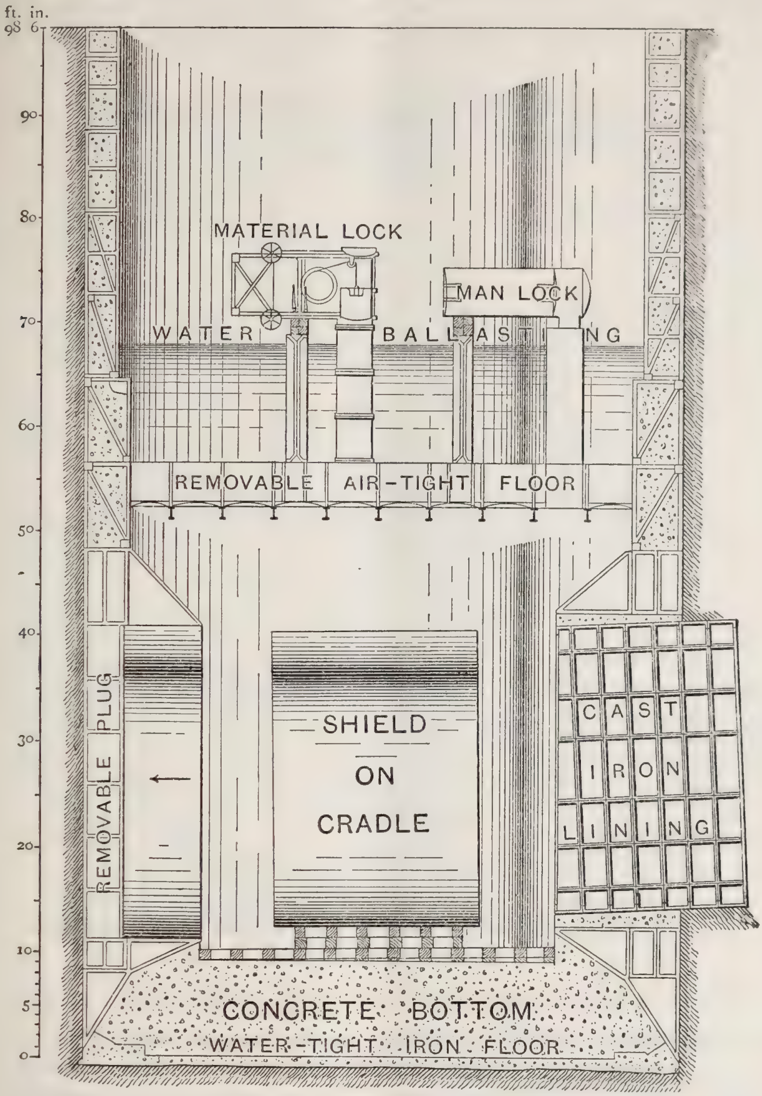
The Blackwall Tunnel is the largest example of cast-iron lined tunnel driven by a shield with the aid of compressed air. The work is being carried out for the London County Council, under Mr. Binnie, their chief engineer, Sir Benjamin Baker being consulting engineer, by Messrs. S. Pearson and Son, of which firm Sir W. D. Pearson, M.P., is the chief. The contract was let in November, 1891, when I was intrusted with the design of the plant and the carrying out of the work by the contractors. Active work was commenced in March, 1892, and Messrs. D. Hay and M. Fitzmaurice were appointed to represent Mr. Binnie as resident engineers upon the work.

We commenced operations by sinking the caisson shafts on the Kent side of the river, as the borings showed there was a thick bed of London clay overlaying the tunnel which extended halfway across the river. Caisson No. 4 was the first to be sunk; it is 58 ft. 2 in. outside diameter at the belt, and is 78 ft. 6 in. deep. The inside diameter is 48 feet, remaining constant; the outer skin, however tapers, the thickness of each plate giving a batter of 1 in 100. The space between the inner and outer shells is filled with concrete at 6 to 1, which, together with the weight of the caisson itself was sufficient to sink it to the bottom. This was not the case with some of the others, which required several thousands of tons added to sink them.

The two openings in the side of the shaft through which the tunnel now passes were, during the sinking operations, closed with temporary plating of sufficient strength to resist the maximum head of water that could possibly come upon them, and were built up in pieces 5 feet square, so that they could be removed within and passed through the shield. The plate work was so arranged as to be usable in the remaining caissons for a similar purpose.

Provision was made for an air-tight floor, or deck, above the tunnel openings, so that, should air-pressure be required, it could be built into any caisson after it had been sunk in the open as far as possible. The floor was made sufficiently strong to withstand 35 lbs. of air-pressure, when loaded with 12 feet of ballast, or its equivalent in water; it has been used on three successive shafts with satisfactory results. It is composed of three systems of girders, two main 12 feet deep and 16 feet apart, nine 4-feet girders and nine 18-inch girders 5 feet apart, all being plate webbed.

Fig. 9.



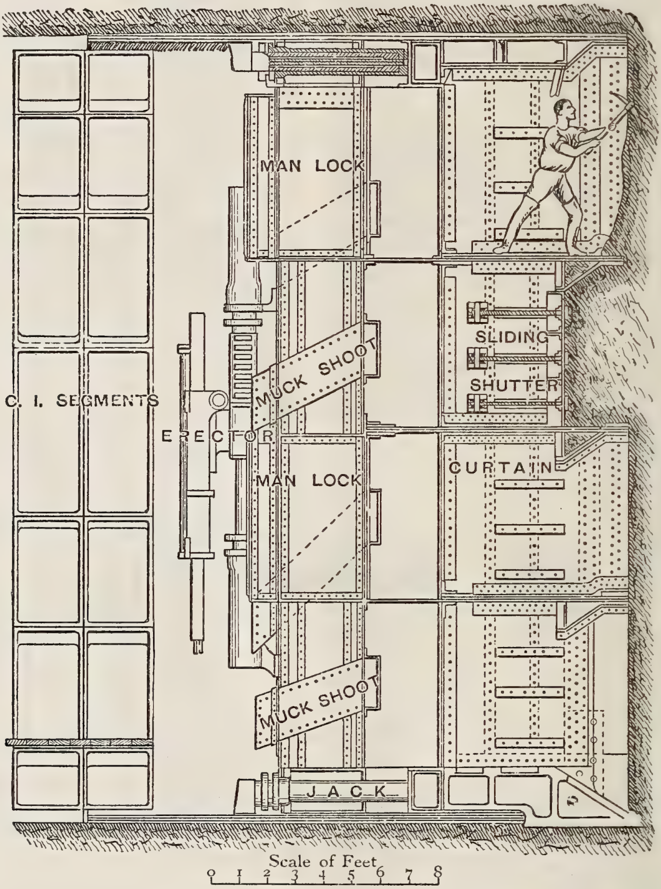
Blackwall Tunnel. Shaft No. 3.

The two main girders with their maximum load have a reaction of 400 tons at each end, and a great deal of careful design was entailed in order to make the thin skin plating of the caisson equal to such heavy isolated loads.

No. 3 caisson was sunk close to the river bank. The wet sand caused great friction, and it was necessary to weight it ultimately to such an extent that 6½ cwt. per square foot of surface was the final frictional resistance. To insure a water-tight bottom to the shafts a light iron floor is put in under the concrete, attached to the caissons by an angle all round.

While shaft 4 was being sunk the shield was being erected, with a view to saving time, in a kind of dry dock adjoining it, the excavatio of which formed part of the cut and cover Arrangements were made for taking out suffi cient of the side of the caisson when sunk t enable the shield to float through the gap drawing 17 feet of water. Its ends wer planked with four-inch deals and caulked, i was carefully ballasted and kept on an eve keel by two five-ton cranes attached to a overhanging girder on the top. The caisso and dry dock were filled with water until the shield floated, when it was drawn by crabs into place, and lowered with the water as it was pumped out.

FIG. 10.



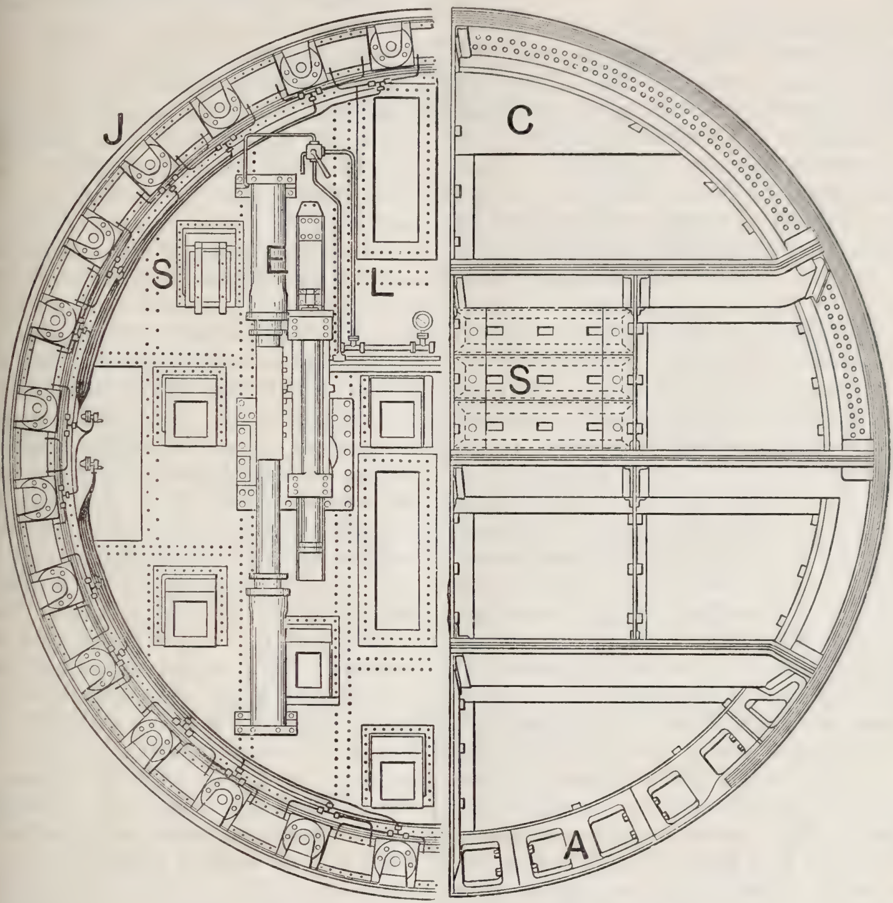
BLACKWALL TUNNEL SHIELD (PEARSON'S PATENT). LONGITUDINAL SECTION.

The filling of the caisson, drawing the shield into it from the dock, and lowering it to the bottom occupied about five days, when it was landed on the cradle of timber and rails, pointing in the direction of the opening in the side of the shafts through which it had to pass on its journey across the Thames. It weighed about 220 tons, and was lowered 50 feet. O the completion of the hydraulic connection and erectors, the cast-iron lining was buil across the shaft to the opposite side, as a re action for the jacks, and the shield was ad vanced into the opening upon cast-iron slides

The temporary plating called a plug wa removed piece by piece from the face, eac plate being replaced by bags of clay, whic took the weight of the earth.

As compared with any other shield previousl made, that in use at Blackwall is unusually strong, but it has not proved any too strong for the work it has had to do. Its diameter is 27 ft. 9¼ in., and it is 19 ft. 6 in. long, the outer skin being composed of four thicknesses of ⅝-inch steel plates, with longitudinal joints, each plate breaking joint and covering the others. There are three horizontal girders with cutting edges, forming air-locked safety compartments. Should there be at any time a blow out of air at the face, and an inrush of water, these compartments would always allow of a man's head being in air, though his body would be in water.

Fig. 11.



Blackwall Tunnel Shield (Pearson's Patent).

L Man Lock. **E** Erector. **S** Muck Shoot. **J** Hydraulic Jack. | **A** Steel Castings. **S** Sliding Shutters. **C** Safety Curtain.

The face is further sub-divided by one main central vertical, and two short verticals which do not pass through the upper and lower horizontal girders. The face is, therefore, cut up into 12 working pockets, there being, roughly, 14 cube yards per ring to be removed from each floor. The shield is divided into two main divisions, on its vertical diameter, by the centre horizontal girder, which is deeper than the ones above and below it, and is attached to an air-tight diaphragm, 9 ft. 6 in. from the cutting edge. This arrangement was provided, in case it should be found possible to work with two pressures of air at the face, the diameter of 27 feet making a difference of nearly 13 lbs. per square inch on the air necessary to balance the water-head at the top and bottom. Each level is provided with two air-locks in the airtight diaphragm, which are so situated that, even should the face of the shield be flooded, there will always be a compartment, air-locked, like a diving bell, into which water could not enter.

Air-locked shoots are also provided upon each floor, through which the excavated material can be shot without serious loss of air. The whole face of the shield, therefore, can be closed up, and worked at an higher pressure than the remainder of the tunnel, which, at very high pressures, might prove an advantage, the minimum number of men being exposed to the maximum pressure. The tail, or hood end of the shield, measures seven feet, and is sufficiently long to overlap nearly two rings.

There are 28 hydraulic jacks, 4 feet stroke, 8 inches diameter, with a draw-back cylinder inside the ram, so arranged that all packing can be done without removing the ram itself. The jack valves are worked by two men, but all movements can be controlled by one. There are four groups of jacks, which are arranged about a vertical centre line, each group having a separate valve, and each pair of jacks has a valve to itself. The hydraulic pressure usually used was 2¾ tons per square inch.

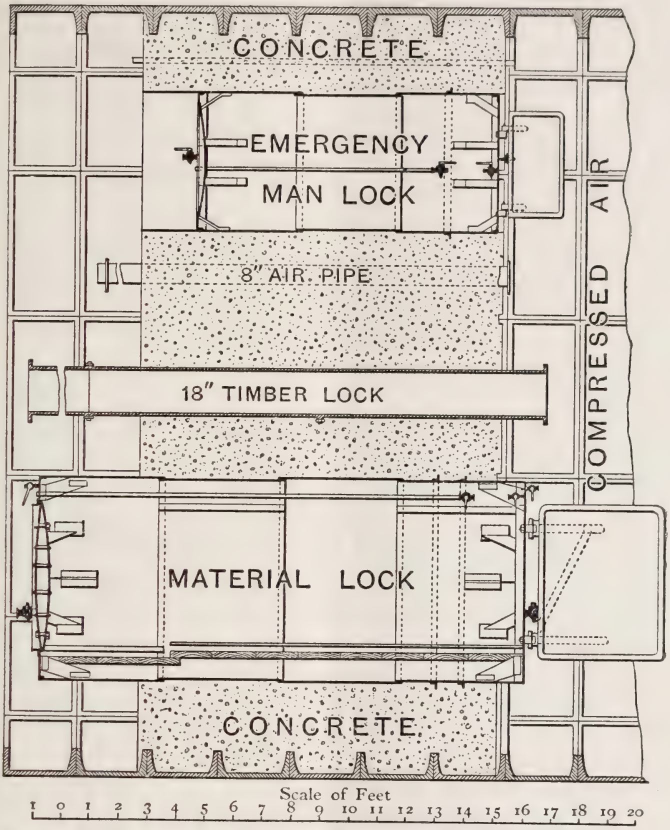
The hydraulic erectors, which are a novelty, have proved very efficient, and handle with ease segments which weigh a ton. There are two of them, their axis being on a horizontal diameter passing through the centre of the shield and placed 4 feet from the vertical centre line. Two vertical single acting hydraulic cylinders 8½ inches in diameter, having between them a toothed rack, revolve a pinion, and to this pinion a hinged cast steel box is attached, through which an H-beam is made to slide by a double acting hydraulic cylinder 4 inches in diameter. A hand wheel and screw adjust the relation between the angle of the box and the shaft, upon which the pinion revolves, so that the distance of the point of the H-beam from the face of the shield may be altered several inches at will. An hydraulic swivel passing through the base which is attached to the face of the shield admits the high pressure water at 1,000 lbs. per square inch to the slewing and telescope cylinders, the water being distributed by slide valves. One man controls the movement of each erector, and a ring weighing 15 tons has frequently been erected in less than one hour. The two erectors and the ram heads are supported on a second plate diaphragm, forming part of, and 12 ft. 6 in. from, the cutting edge of the shield. The cast-iron lining is 27 feet outside diameter, each ring being composed of fourteen segments and a key-piece, and the ring measures 2 ft. 6 in. along the axis of the tunnel. The flanges are 12 inches deep, and th metal 2 inches thick at the back. Each ring i connected to the last by seventy bolts 1½ inc in diameter, while each of the joints running parallel to the axis of the tunnel are connecte by five 1½ inch bolts, giving them as great beam strength as solid castings. The bearing surfaces are all planed for a depth of 10 inches the remaining two inches being reduced, s that when the plates are connected there is space, two inches by half an inch, into whic cast-iron rust borings are caulked to make al watertight. No packing of any sort is use between the plates.

When the tunnel had been driven 175 feet th shield began to cut through the London cla into a bed of sand below. In isolated spot between the sand and clay were beds of shells which in some cases had formed into a sort o hard limestone rock, sometimes two feet thic in the centre, tapering to nothing at the edges and from 6 feet to 12 feet in diameter. Before th first of these had been discovered, and that th sand bed was coming within the area of th shield, it struck such a piece of rock at th bottom which turned up the cutting edge to considerable extent. It became necessary, i consequence of this, to drive a bottom heading in advance of the injured cutting edge, and t put in a concrete bed to the true shape of th undamaged part of the shield, upon which i could slide. This was done until shaft No. was reached, where the injured part was cu out and replaced by steel castings. The firs few hundred feet of the tunnel were drive from shaft No. 4 without air pressure, but o nearing shaft No. 3, which had caused muc trouble while it was being sunk, the groun became so treacherous that it was deeme necessary to use it. The air-engines wer already fixed, and it was only necesssary t build the bulkhead across the tunnel betwee which and the working face the air was com pressed to a sufficient density—some 24 lbs. t the square inch above the atmosphere—t keep out the water.

The bulkheads are 12 ft. 6 in. thick, and ar built in cement brickwork. They are provided with three locks passing through their thickness, and projecting beyond in some cases. The various pipes for air and water at different pressures, the electric wires, &c., also run through them.

The two working air-locks are circular in form, being 7 feet in diameter, and 16 feet long. They are provided with two door openings 5 ft. × 4 ft., clear. Both doors open towards the working face, and close air-tight upon rubber faces. In operating them, one door is alwas kept closed, and the space between them fulfils the same function in relation to the air as does the space between canal lock gates to the water in the higher or lower reaches of the canal. It is a space in which the air-pressure can be gradually raised or lowered at the will of the person within it. The air is controlled by two 1½-inch taps for letting the air in and out—one at either end—and a 2½-inch tap for the more speedy letting out of the muck waggons, two of which can be let out at once. The waggons are then hauled, by endless ropes, to the foot of the shaft, raised to the surface in a cage, where they are capsized in a tumbler, their contents falling into ordinary waggons to be run to tip. The upper or emergency air-lock is only used as its title implies, in the event of the lower ones being drowned out by a sudden influx of water, which occurred twice while we were going under the river.

FIG. 12.



BLACKWALL TUNNEL. LONGITUDINAL SECTION OF CONCRETE BULKHEAD AND AIR LOCKS.

A few hundred feet from the inside face of the diaphragm a hanging screen coming halfway down the tunnel was fixed and made air-tight, so that in the event of the water suddenly rising above the centre of the tunnel, it could at no time flood the emergency lock, and would be a refuge, like a huge diving bell, where the men could always have head room and a means of getting to the open air. In or under clay, or in strata which does not allow the air to escape, and which can be kept dry by the air, there is no necessity, provided the shield is made sufficiently powerful, to get out into the front to cut away the earth; it is only necessary to channel the face round the cutting edge, and the shield will do the rest of the work at a greater speed, and with more safety, than if a chamber were excavated in front and the shield pushed into it afterwards, as is frequently done.

At Blackwall we progressed, for more than two months, at the rate of 252 ft. 6 in. per month under the Thames, and removed more material than has ever before been removed from a single face in any tunnel in the time. The borings indicated, and the sinking of shaft 2 on the Middlesex side proved, that there was a large bed of ballast, through which the tunnel had to be driven. This ballast was struck in the roof, 725 feet from the centre of shaft 3, and made itself evident by the large amount of air that escaped through it and bubbled up in the river. A stoppage of about 10 days was made, in order to fit sliding shutters on to the shield. The shutters are controlled by a screw at each end, which keeps them up against the face of the unexcavated material. If we assume that they have been screwed out towards the cutting edge, as far as they will go, the shield is then ready to be pushed forward. Immediately the pushing commences the nuts on the shutter screws are loosened, and as the shield moves ahead the shutters slide back, the space in front of them becoming filled with gravel. As soon as they have slid back as far as they can come this gravel is excavated, the shutters again screwed forward, and the same process repeated, until the shield has been moved 2 ft. 6 in., or sufficient to allow of another cast-iron ring being erected within the thin iron hood which overlaps the last completed ring at the back of the shield.

The space left outside the lining by the advancing shield was filled up with lime grout, Mr. Greathead's apparatus being used for this purpose.

While the gravel was being taken away from the front of the shutters large quantities of air continually escaped. It was often impossible for days at a time to open the upper shutters as all, the whole of the excavation being removed through small openings, 3 inches by 7 inches, in the shutters, which could be immediately closed by a small sliding door. On opening these small doors I have often seen the stones churned into such a turmoil with the escaping air that the fire was flying from them. Progress under these conditions was very slow and sometimes disheartening. During one week only five feet of cast-iron tunnel was completed, but as the men became more used to the work and additional jack power was provided, it became possible to ultimately fix 20 feet a week, or 65 feet in one month, in the gravel, as against 255 feet while under the clay.

The crown of the tunnel at one point came within 5 ft. 6 in. of the old river bed for a distance of about 150 feet, and the material composing this 5 ft. 6 in. was all Thames

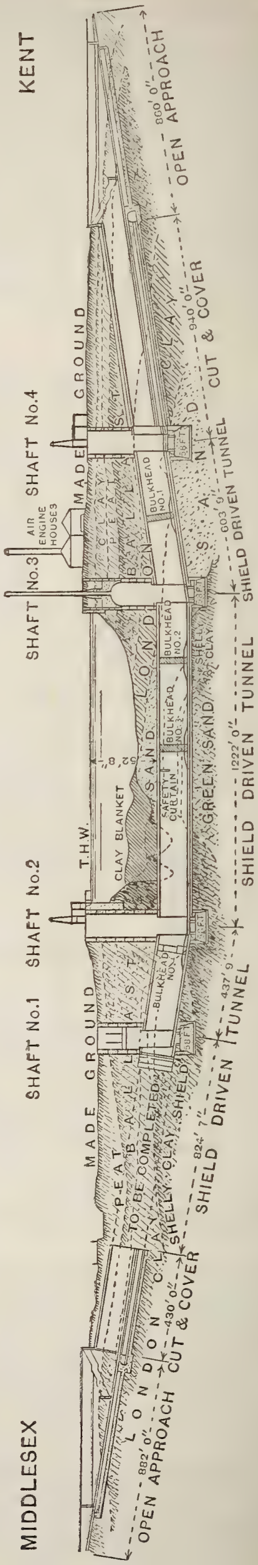


Fig. 13.

Blackwall Tunnel. Longitudinal Section.

ballast. We applied to the Thames Conservancy to allow us to put a huge plaster of clay over this part of the bed, 150 feet wide and 15 feet thick, which permission they granted, and there is little doubt that we could not have made the tunnel at this point without this clay plaster. Frequently, for days on end, we drove the top of the shield, as the diagram shows, through the clay which we had ourselves dumped in the river, the natural bed having been entirely removed below.

Having passed beyond a part of the clay bank, it was dredged up and re-deposited further ahead, where it again did faithful duty. All the time that this portion of the work was being constructed, great care was exercised in regulating the pressure to suit as nearly as possible the tide in the river, for a slight increase over the hydrostatic head would have blown the artificial clay bed off. This, as a matter of fact, occurred on two occasions, when the tunnel became one-third full of water in less than five minutes. We endeavoured to keep the air at the pressure of the water at the top of the shield, to save as much as possible the risk of a blow-out, and, in consequence, had to deal with an immense inflow of water through the gravel at the bottom. It would have taken about 13 lbs. per square inch more at the bottom of the shield than at the top to dry the tunnel completely, owing to its large diameter. It is very difficult to really tell what the head of water is in a case of this sort, as the escaping air drives some of the water out of the ballast, thereby reducing its depth, and the bubbles of air being mixed with the water also lightens it.

We started out under the river on September 16, 1894, when we fixed the first ring; and we struck No. 2 shaft on September 26th, 1895, having done the distance in less than twelve months, allowing for delays due to fixing the shutters and the ice pack in the river in February, 1895, when we could neither handle or deposit clay over our heads, and that which was there became dangerously thin.

We have now passed through No. 2 shaft on the Middlesex shore, and have driven the uphill grade to No. 1 shaft, and will soon be working on the last lap which finishes on the Poplar side of the Great Eastern Railway branch line, where the "cut and cover" portion of the tunnel is already awaiting us. We are proud to think that we have lost no lives in the tunnel proper, or due to the effects of compressed air, as we had reason to fear we might.

After the completion of the cast-iron tube there remains but the concrete, white glazed lining, and the road surface to finish, when the Blackwall Tunnel will commence its career of usefulness.

I have not described the "cut and cover" and "open approaches," because similar work has been done so often before, the most notable instance in London being the Metropolitan and East London Railways. "Cut and cover" means, as its name implies, the cutting of a deep trench, the building of the tunnel inside it, and the covering of it in again.

The Blackwall Tunnel is remarkable for several things. It is the largest shield-driven tunnel ever constructed. It is the only example of a tunnel which has been driven through ballast under a river bed, and that too within 5 ft. 6 in. of it. It is the only large subaqueous tunnel that has been undertaken by the contractor at a fixed price, all the others having been undertaken by companies, who have paid on a basis of prime cost. It is acknowledged by the leading experts to be the most difficult piece of tunnelling ever undertaken.

As the lining of cast-iron tunnels costs from 30 to 40 per cent. of the total expenditure (in the St. Clair Tunnel it was about 33 per cent.), it is a pity that some scheme has not been tried for reinforcing the lining, using temporarily a thinner casing, and ultimately strengthening it with concrete or brickwork. Concrete might be used, and is being used, with great advantage in the lining of railway tunnels; and I do not see in the London clay and similar strata—absolutely watertight—why half or two-thirds of the lining should not be removed, and the lining so removed be in short lengths replaced by concrete. An additional key could be inserted in the bottom of the lining, which could be drawn out by a union screw or a hydraulic jack from above. Of course, in the case of gravel or water-bearing strata, it could not be done with advantage—by this means the high rate of progress due to the cast-iron lining could be maintained without so much cost.

Some of the contractors working on the recently-constructed cast-iron lined tunnels in Glasgow, have driven considerable portions without the aid of any shield whatever, simply excavating the clay or sand and building the rings in place. A light cast-iron ring, reinforced by cross ties and struts of wood, until the concrete lining was put in, would be very much less expensive than a cast-iron one of equal strength, and the plates, being lighter, would be more easily handled.

In conclusion, I have to express my thanks to Sir Frederick Bramwell and Mr. Greathead, for the loan of the diagrams representing Lord Dundonald's patent and the South London Railway. I wish, also, to express my thanks to Messrs. Tabor, Halden, Adam, Collingridge, Everett, and Price-Williams, who have worked hard to produce the diagrams which I have brought before you, and who, throughout this long and anxious work, have done their best to help me at any hour in the twenty-four. I would also record the names of our leading foremen, who have, with the men, done so much to make the tunnel a success. Their names are James Blackburn, Patrick Ryan, Robert Mitchell, James Mace, and Joseph Hall.

DISCUSSION.

The CHAIRMAN said he was sure every one would agree that the Council of the Society had exercised a wise discretion in asking Mr. Moir to give a paper on the Blackwall Tunnel, and they would also appreciate the great descriptive power which had been shown in the paper, and the excellence of the diagrams which illustrated it. It was interesting to recognise that so far as back 1818 the genius of Brunel had gone very far towards elaborating the system of driving tunnels in subaqueous strata by means of shields. He had then to struggle with imperfect appliances, and being the pioneer in this kind of work, was overwhelmed with difficulties, financial and otherwise. Still, all engineers must recognise that in Sir Mark Isambard Brunel's shield, which much resembled a row of books, each of which was moved forward one at a time, they had the germ of all those appliances which had since been used for similar purposes. It was also interesting to know that Brunel in one of his patents described a circular shield, which was not very dissimilar to those which had afterwards been so successfully applied by Mr. Moir and others. They must also recognise how far the Earl of Dundonald was in advance of his time, by the patent which he elaborated for the use of compressed air in works of this kind. He did did not know that the idea ever went much farther than the description in the patent, but no one could look at the diagram representing it (p. 569), without seeing that he had grasped the idea of driving a tunnel horizontally by compressed air, just as, not long afterwards, people began to drive tunnels vertically for the foundations of bridges by the same agency. The next interesting departure took place when Mr. Greathead introduced the system of ejecting the grouting outside the lining of a tunnel driven through the London clay, or an aqueous strata, which had contributed so largely to the success of later works. They must all appreciate the extraordinary pluck which was shown in the attempt to drive the tunnel under the Hudson River, and those who had followed the history of that struggle against difficu ties of all kinds, partly financial, must regret ver much that there still remained 1,600 feet of tha tunnel to be completed. The value of the medic lock, in which workmen suffering from the effects compressed air were treated, was very great; seemed to him a most excellent and scientific ide and must have proved a great service at Blackwa and elsewhere. He did not know to whom th credit of it was due, but shrewdly suspected that was Mr. Moir. They must all feel proud tha the Blackwall Tunnel had been brought to suc a successful completion—for it was practicall complete now—considering the great difficultie of the work. He could not help thinking that th top of it was rather unduly near the bed of the rive but having had to report upon it some few yea ago he recognised the extraordinary difficulty the would have been in lowering the tunnel in order t increase the cover. It was, of course, a battle be tween the gradient of the approaches at the bank and the possibility of constructing it at the lev adopted. The driving of such a large tunnel withi 5 ft. 6 in. of the bed of the river was a success which anyone might be proud, and they would a congratulate Mr. Moir upon it; though when all wa said and done he fancied that if the work had to b done again, Mr. Moir would be very glad if he had margin of 15 feet instead of 5 ft. 6 in. When calle upon to report upon it, he suggested that if a some what greater depth were adopted, a larger tunne should be driven, and though he quite realised th difficulties of driving a large tunnel, he still feare that the present one would prove rather small for th traffic which would come upon it; and now that thi had been successfully achieved, he apprehended ther would be no difficulty hereafter in driving one larger dimensions. However this might be, the would all recognise that the history of the Blackwa Tunnel was a record of unprecedented ingenuity resource and determination in overcoming difficultie which arose from day to day. They must congratu late all concerned on the fact that no lives had bee lost during the work, and whilst recognising the grea scientific work of the engineers who designed th work and prepared the drawings they must als recognise the extraordinary skill shown by those t whom were entrusted the carrying of it out; an foremost amongst these was the gentleman who ha read the paper.

Sir WILLIAM ARROL said it had been a grea pleasure to him to hear this paper descriptive of th Blackwall Tunnel. He had been familiar with th subject since it first came before the House of Commons, and was one of those who had the audacity t say he would make it if it were to be made; and wher it was originally suggested by Sir Joseph Bazalgette he actually signed an agreement to the effect that he would make it and would make the plant for carrying it out. Circumstances changed, however, and he did not see his way to tendering for it when the time came, as he had other very important work on hand, and did not care to spend the few remaining years of his life working underground. But Mr. Moir was a man to whom the contractors might entrust the execution of such a work with the most perfect confidence. He well remembered his first coming to him, as a very young man indeed, without any introduction, and asking to be employed and paid whatever he was worth. He liked his looks, and put him to work on the Forth Bridge at once. At first he was employed in the office, but went on to the works and superintended the construction of the large caissons which were employed, and ultimately the erection of one of the large cantilevers. After that the tunnel on the Hudson was being estimated for, and his firm having the making of the shields, Mr. Moir was selected to see to their use, and the carrying through of the undertaking. He had the pleasure of seeing him in New York while the work was in progress, and could testify to the successful manner in which it was carried out under great difficulties. He was very pleased to hear of his success in this Blackwall Tunnel, the men engaged on which he believed had nearly all come from the Forth Bridge, and it was certainly an object-lesson to engineers.

Sir WEETMAN PEARSON, Bart., regretted that he had not been able to come in time to hear the whole of the paper, but no one could appreciate the work Mr. Moir had had to do, or the magnificent manner in which he had performed it, better than himself. He could endorse every word which Sir William Arrol had said about him. He had had the full responsibility in carrying out the work, and if any mistakes had been made they had been on the right side, viz., of excessive caution; and if it had not been for that, the tunnel would certainly not have been so far advanced as it now was. Mr. Moir had practically had a free hand, and it was very largely to his credit alone that the work was now in the state to which it had arrived. He could not overstate the care and determination which he had devoted to it.

Mr. D. HAY being called upon, said Mr. Moir had not left him anything to say about the tunnel, but he was glad of the opportunity of bearing his testimony to the originality, zeal, determination, and genius which he had shown in carrying out the work.

Mr. R. PRICE-WILLIAMS said that, while listening to the remarks of the Chairman, he could not help thinking how much was to be learned by experience in a new direction, and that brought to his mind that on a recent occasion at the Institution of Civil Engineers, it was his privilege to listen to a paper on an engineering work which had failed, and a very pertinent remark was made at that meeting that it was the duty and privilege of members of the profession to bring forward the results not only of successes, but also of temporary failures, as object-lessons and means of education. In this interesting paper it was very gratifying to observe not only the skill and resource with which the work was carried out, but the beginning of a new departure. He had recently come from one of the colonies where an attempt had been made to utilise this novel system, but which signally failed, and the moral he drew was simply this, that an attempt was there made to carry out a work without the necessary education and resources, such as Mr. Moir possessed. On behalf of the whole engineering profession, he desired to thank Mr. Moir, not only for this paper, but for the instruction he had given them, and he could not help thinking that, in the light of the success now achieved, many other similar works would soon be called for.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Moir, to which he would add their congratulations to Mr. Binnie, Mr. Hay, Sir Benjamin Baker, and the whole of the staff engaged in the work.

The vote of thanks having been carried unanimously,

Mr. MOIR, in reply, said the whole of those engaged had worked very harmoniously, and though there had been differences of opinion sometimes, they had always been good friends. He must express his thanks to Sir Weetman Pearson, who had given them everything they asked for, even when, as sometimes happened, it proved to be unnecessary, and this liberality on the part of the contractor had contributed very largely to the success of the work, by infusing a spirit of confidence in everyone concerned in it.

Obituary.

P. J. MARGARY.—Mr. Peter John Margary, a member of the Society of Arts, died at the end of April at his residence in London, from heart disease, at the age of 75. He was one of the assistants of I. K. Brunel in the construction of the Bristol and Exeter Railway, and subsequently of the South Devon line, of which and its branches he became chief engineer on the death of Brunel. On the amalgamation with the Great Western Company, Mr. Margary was appointed resident engineer of the western division of the system, a position he retained until 1891, when he retired from the service.

General Notes.

LISBON EXHIBITION, 1897.—The correspondent of the *Times* in Lisbon states that the fourth centenary of the discovery of India (by this doubtless is meant the discovery of the route to India round the Cape of Good Hope) by Vasco da Gama will be celebrated by an Exhibition in Lisbon next year of Indian products, in which Senhor Aronca is instructed to invite England to take an important part.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

MAY 20.—"Orthochromatic Photography." By CAPT. W. DE W. ABNEY, C.B., F.R.S. Professor H. E. ARMSTRONG, LL.D., F.R.S., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

MAY 19.—"Bronze Casting in Europe." By GEORGE SIMONDS. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., Vice-President of the Society, will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.

LECTURE IV.—MAY 18.—Calcium Carbide—Aluminium—Miscellaneous processes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 18 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Swinburne, "Applied Electro-Chemistry." (Lecture IV.)

Geographical, University of London, Burlington-gardens, W., 8¾ p.m. Prince Henry of Orleans, "From Talifu to Assam."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Robert Fellowes Chisholm, "Baroda Palace: the Town Residence of H.H. the Gaekwar."

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Grant Bey, "Climate in Egypt."

TUESDAY, MAY 19 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. George Simonds, "Bronze Casting in Europe."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. Vernon Boys, "Ripples in Air and on Water." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Royal United Service Institution, Whitehall, S.W., 5 p.m. Mr. Robert A. Yerburgh, "Agricultural Credit Banks."

Pathological, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Photographic, 12, Hanover-square, W., 8 p.m. (Photo-mechanical Meeting.) Mr. Ignatz Herbst, "Photo-mechanical Methods in Austria."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. M G. E. H. Barrett-Hamilton, "An Interestin Variation in the Pattern of the Teeth of a Specimen of the Common Field-Vole." 2. Mr. F. E Beddard, "Contributions to the Anatomy o Picarian Birds.—No. III. The Anatomy of th *Alcedinidæ*."

Colonial Institute, Northumberland-avenue, W.C 4½ p.m. Mr. Arthur Clayden, "Our Coloni Food Supplies."

WEDNESDAY, MAY 20...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Capt. W. de W. Abne "Orthochromatic Photography."

Meteorological, 25, Great George-street, S.W 7 p.m. 1. Mr. Richard H. Curtis, "The Exposure of Anemometers." 2. Collection of 60 Photographs of Clouds, by Mr. H. C. Russell, o Sydney Observatory, will be exhibited.

Microscopical, 20, Hanover-square, W., 8 p.m.

Archæological Association, 32, Sackville-street, W 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C 4 p.m. Annual Meeting.

Geological Museum, Jermyn-street, S.W., 8 p.m 1. Mr. Wilfrid Wybergh, "Estimating and Sampling Ore Reserves, as Practised on the Witwatersrand, Sonth Africa." 2. Mr. R. G. Brow "Notes on the Treatment of Zinc-box Precipitat ('Slimes') from the Cyanide Process, as Practise at the Standard Consolidated Mines, Bodie, California." 3. Mr. J. H. Collins, "Note on a Safet Hook used in California and other Deep Mines o Colorado."

THURSDAY, MAY 21...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Messrs F. D. Chattaway, M.A., and R. C. T. Evans, "Th Diphenylbenzenes—I. Meta diphenylbenzene." 2 Dr. F. S. Kipping, "Derivatives of Camphori Acid." 3. Mr. W. J. Pope, "Some Substance Exhibiting Rotary Power, both in the Liquid an Crystalline States."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Hamilton Jackson "Gesso—in Relation to Decorative Painting."

Royal Institution, Albemarle-street, W., 3 p.m. Mr W. Gowland, "The Art of Working Metals i Japan."

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MAY 22...United Service Inst., Whitehall-yard, S.W. 3½ p.m. Major C. B. Wayne, "The Difficulties o the Defensive." (Lecture II.)

Royal Institution, Albemarle-street, W., 8 p.m Weekly Meeting, 9 p.m. Prof. J. A. Ewing "Hysteresis."

Philological, University College, W.C., 8 p.m Annual Meeting.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington house, W. 1. Mr. R. Appleyard, "Dielectrics." 2. Mr. J. Viviamu Jones, "The Field of an Elliptical Current." 3. Mr. A. Campbell, "An Instrument for Measuring Frequency."

SATURDAY, MAY 23...Royal Institution, Albemarle-street, W. 3 p.m. Mr. F. Corder, "Three Emotional Composers." (Lecture III. Liszt.)

CORRECTION.—The notice of the meeting of th Foreign and Colonial Section in the last number o the *Journal*, p. 555, was by mistake headed "Applied Art Section."

Journal of the Society of Arts.

No. 2,270. Vol. XLIV.

FRIDAY, MAY 22, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening, 17th June.

Each Member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be published in the *Journal* later on.

CANTOR LECTURES.

Mr. James Swinburne delivered the fourth and last lecture of his course on "Applied Electro-Chemistry," on Monday evening, 18th inst.

On the motion of the Chairman (Mr. Francis Cobb), a vote of thanks to the lecturer was passed.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, May 14th, 1896; The Right Hon. Sir Richard Temple, Bart., G.C.S.I., C.I.E., in the chair. The paper read was on "Tea Planting in Darjeeling," by G. W. Christison.

The paper will be published in a later number of the *Journal.*

APPLIED ART SECTION.

Tuesday evening, May 19th, 1896; Professor W. C. Roberts-Austen, C.B., F.R.S., Vice-President of the Society, in the chair. The paper read was on "Bronze Casting in Europe," by George Simonds.

The paper will be published in a later number of the *Journal.*

Proceedings of the Society.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 20, 1896; Professor Henry E. Armstrong, Ph.D., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barrett, Frederic, Rosefield, Staines.
Brown, Thomas Forster, Guildhall-chambers, Cardiff.
Pearson, Sir Weetman D., Bart., M.P., 10, Victoria-street, S.W.
Young, J. Denholm, 2a, Tower-chambers, Old Church-yard, Liverpool.

The following candidates were balloted for and duly elected members of the Society:—

Aiya, V. Nagam, B.A., Settlement Dewan Peishcar, Travancore, South India.
Boardman, James, 88, King-street, Manchester.
Gibbs, Edward Mitchell, 15, St. James's-row, Sheffield.
Stiff, James Arthur, London Pottery, Lambeth, S.E.

The paper read was—

ORTHOCHROMATIC PHOTOGRAPHY.

By Capt. W. de W. Abney, C.B., F.R.S.

It may be doubted if the principles of orthochromatic photography are as well understood as is the name. It is known of course that its meaning is the correct rendering of colour on a monochrome print, printed from a photographic plate, but how this is is accomplished is scarcely so well understood. To photograph pictures so that they are not obviously wrong in colour rendering may be considered as the use to which this branch of photography is usually put, and if we can render the colours in a picture properly, we can render any of them in any subject. Indeed, I will go so far as to say that if we can render a red, a green, and a blue, fairly correctly, we can render any other colour equally truly. As I am only going to speak of the principles of orthochromatic photography, and not to speak the many photographic nostrums which are extant to effect it, I shall begin at the beginning so far as I can.

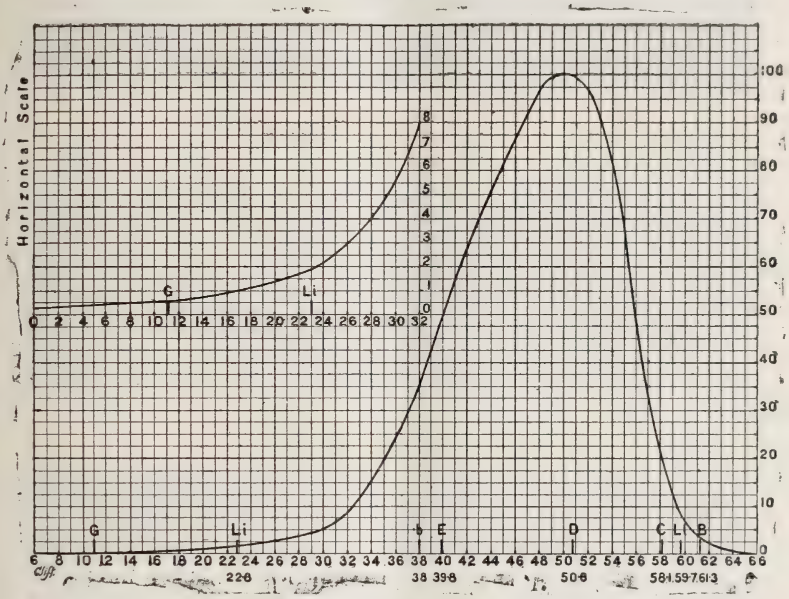
We say that one colour is brighter than another, or more luminous, and we may generalise, and say that one colour has more luminosity than another. It may, perhaps, be hard to say how one may judge that a red and a green have equal luminosities. It has been said by the highest authority on colour, Helmholtz, that he could not picture a method by which a red and a green might be matched for brightness. But yet there is an intuitive instinct, if one may call it so, by which the brightness is judged, and it is this instinct which enables us to get accurate and repeatedly concordant measures of the luminosities of different colours. For instance, on the screen are presented two squares side by side, a white and a green. Everyone will say that the white is the brighter. By inserting in the beam an apparatus to cut off a portion of the white we can reduce the white to a luminosity which is evidently less than the green. Between these two brightnesses of the white there is some place where the brightness of the one will be equal to the brightness of the other. When by careful movement of the apparatus we arrive at this place, we can read off the amount of the original white light that has been cut off and note it. We can then replace the green colour by a red, and we go through the same operation. Evidently then we can tell the relative brightnesses of the red to the green by a simple reference of both to the white. But here again we are met with our first difficulty. Supposing we proportionally reduce the light falling on each we shall see that the brightnesses no longer hold. For instance, in the beam of the electric light we have two patches of colour, a green and a red, and the red is evidently much the brighter of the two; we can cut off the same amount of light from each, and we shall soon see that the red becomes the darker of the two colours, showing that the intensity of the light has much to do with the luminosity of the colours. To judge, then, of the luminosity of the colours, we must know the intensity of the light which calls them into being. Thus, a picture in which there was red and green might, under bright illumination, show a particular red, as brighter than a particular green, whereas, in a sombre light, the reverse might be the case. It is well known that towards evening, the last colours which appear vivid to the eye in pictures in a picture gallery are the blues, the reds disappearing early.

That, then, is one great difficulty, but a second one crops up, which is also physiological. If we place a blue-green and a red in juxtaposition in large masses, the blue-green may appear much brighter than when the same colours are presented in small portions (I am only taking these as typica colours), and there must be some reason for the change. The reason is that, in the centre of the eye we have a yellow dye staining a small central part of the retina, and that this dye cuts off a large proportion of the blue when the light forming the image has to pass through it, as is the case when the masses are small. When the masses are large the image of the blue falls on the retina beyond this stained small portion, and the full effect of the colour is felt. In a picture then it is evident that the luminosity of a small patch of blu will not be the same as it would be if the patch were large. Now I have heard remarks mad somewhat disparaging the writer's measurements of the various colours in a certai colour chart, because, forsooth, his values di not follow the same order as that which independent observers saw when the chart wa gradually moved away from the eye. Th writer made the blue brighter than a red, if h mistakes not, whereas these observers made th red the brighter, because it appeared so whe looked at from a distance. The reason i obvious; both were probably right, but the conditions under which the judgment was forme was different. We can imitate what is seen b the retina beneath the yellow spot by using pale yellow glass over half a patch of blue The blue is very largely cut off by th yellow glass, as it is by the yellow spot. The there is another difficulty, and that is the kin of light used for viewing the colours. If w have blue sky to illuminate the picture it i evident that the preponderating blue of thi light will show up the blue of a picture mor than would be the case if the, comparativel speaking, yellow sunlight, or light from th clouds, were illuminating it. Artists are know to complain of coldness of a picture whe viewed in the light from a cloudless sky. Th warm colours are not then so well shown u by the sky light.

Art often, like necessity, has no laws. On is often tempted to smile at some art crit cisms of colour values in pictures. It woul puzzle a good many of the critics, for instance, to explain what is the explanation o painting in a high key or a low key, an the difference that exists in colour contrasts i the one kind of painting and in the other. A has its many delights, and art criticism its many pleasures—that is, for the art critic. But it would be a good discipline if a few of the laws which must underlie a knowledge of colour were studied, when doubtless a criticism on a picture would be much more valuable than it often is at present. For instance, when a picture is seen through half or more than half closed eyes, the chromatic scale is altered, and the relative brightnesses or values of the different tints is entirely changed, as may be gathered from our experiments. The artist often uses this artifice when painting from nature, and rightly too, for he has, from experience, learnt the kind of light in which his picture will be viewed. But there is no reason for the critic to adopt the same plan in the studio. But I will pass on. It needs no seer to see that the rendering of the colour in a picture in monochrome with exactness is by no means an easy thing. The physiological effects, in which we must include contrast, besides the merely physical ones, have to be reckoned with. When we look at a picture, we may take it that in this country, at least, the light in which it is seen most commonly is sky light, with clouds in the sky. Now, the electric light is a very fair imitation of bright sunlight, and as cloudlight is, for the most part, reflected transmitted sunlight, it is quite fair to judge of the luminosity of colours in such a light.

Placing a coloured print in the electric light we see every colour nearly as we should see it in daylight in midday on a day with average light. And one thing must be said, that after a certain illumination is attained, the relative brightness of colours does not alter, so that if we use a very bright light for our measurement, we are not doing an injustice to any picture. We shall not be wrong then if we assume we have arrived at a quality of light which we may adopt as a standard.

FIG. 1.

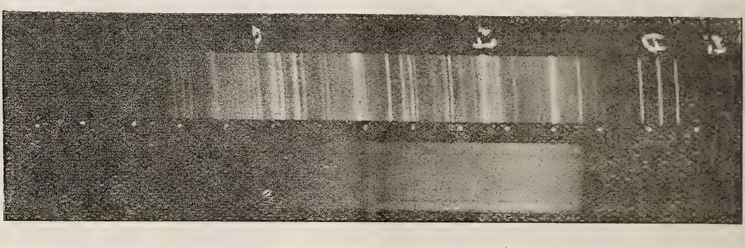


The next point is the question of the size of the patches of colour we are to use. Now when we examine a picture, only a small area will be in focus on the retina, and this area will fall on its centre, where the yellow pigment is situated. The picture is practically taken in by a movement of the eyes, so that each area in succession is examined, and it is the sum of these impressions which gives us the mental image of the picture. I trust no one will doubt that if we are to measure the brightness of a colour in a picture, we ought to receive the image so that practically it will fall upon the yellow spot, and if we do so we shall be on the right road to obtain measurements which are practically useful.

Now to gain a real knowledge of the colour of pigments, or of light transmitted through transparent bodies, such as glass, we are forced to have resource to the spectrum, and if we wish to know the orthochromatic value of a photographic plate we must again have recourse to the spectrum. I will not waste time by repeating what I have often shown before, viz., the spectrum luminosity as it appears to ordinary eyes; I will simply throw the luminosity curve on the screen (Fig. 1). It will be seen that in the yellow and yellow-green we have the maximum brightness, and by an artifice we can show how the spectrum in monochrome should be represented. The luminosity at each point of the spectrum is represented by white light of varying brightness by rotating a template which has been properly graduated, in front of a slit, an image of which is thrown o the screen. If we can obtain a plate whic would give a negative of the spectrum whe exposed to it and developed, and which, whe decently printed, would give such a graduate scale, we should have a means of reproducin any colour in nature. Now let us see how fa off we are from obtaining this.

On the screen we have a print from negative of the spectrum of gaslight taken o an ordinary plate (Fig. 2). It will be see that by far the brightest part is that which represents the blue of the spectrum. The line spectrum above shows an electric arc spectrum. It gives the position of the colours, and indicates that had the source to light to form the continuous spectrum been that of the arc-light, this preponderance of blue would have been still more marked. The yellow has no luminosity to speak of, though it is brightest to the eye, and the red does not show at all. Early in the seventies Dr. H. W. Vogel, of Berlin, showed that by the addition of certain dyes—derivatives of fluorescin principally—that the same plate became sensitive to certain rays, to which before it was insensitive. Later researches have shown that erythrosin and eosin were effective in rendering yellow and green. The speaker was amongst the first to show that the simple chemical compound, cyanine, rendered a plate sensitive to the yellowish-red as well as to the yellow. How we are to account for this new sensitiveness has been much discussed. The author retains the same belief that he held at first, that the new sensitiveness is due to a decomposition, by light, of the dye itself, and that the intimate mixture of this product with the sensitive salt gives a nucleus on which silver will deposit in exactly the same way that it will deposit on a glass plate on portions which have not been properly cleansed. Dyes which are most effective are those which are most fugitive, and this has a bearing on the subject. It must be recollected that to produce the ordinary photographic image the amount o material which has to be acted upon by light i so small that it is unimaginable and invisible

FIG. 2.



I will show you an example of a dye acte upon by light which has subsequently bee developed by the application of silver. Th plate was coated with collodion and cyanin blue, and exposed to the spectrum. It wa subsequently coated with an emulsion whic had never seen light, and you see that wher the cyanine was bleached we have silve deposited.

But I must pass on. On the screen we hav two samples of prints of the spectrum fro negatives taken on plates rendered colou sensitive by means of erythrosin and cyanine (Figs. 3 and 4.) You will see that in all thes cases the problem is not solved theoreticall because there are gaps of insensitiveness t the spectrum. When we dye the plate wit both cyanine and erythrosin we get a combination of the two added sensitivenesses. Thi is shown very fairly in Fig. 5. In commerc three are several plates extant which are partially colour-sensitive. Figs. 6 and 7 sho the sensitiveness to the spectrum of Obernetter and Edwards's plates to a gaslig spectrum, and the remarks that were mad regarding Fig. 2 apply to these so far as th increased action of the arc light or dayligh that would take place are concerned.

The measurements of the above spectrum have all been given in a paper read a few years ago before the Royal Society, and their curves of sensitiveness were diagrammatically shown. Since that time there are other plates which have been introduced, and I have measured the sensitiveness of most of them nd here give examples of Lumière's plates, ne sensitive to the red and yellow of the spectrum, and the other sensitive to the red, yellow, and green of the spectrum (Fig. 8).

Fig. 3.

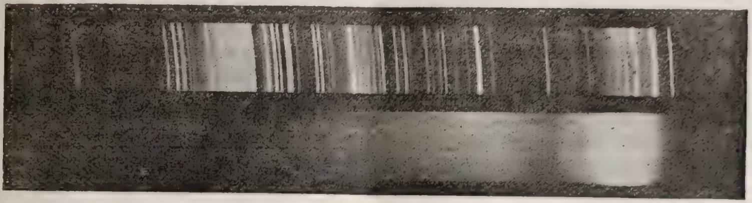


Fig. 4.

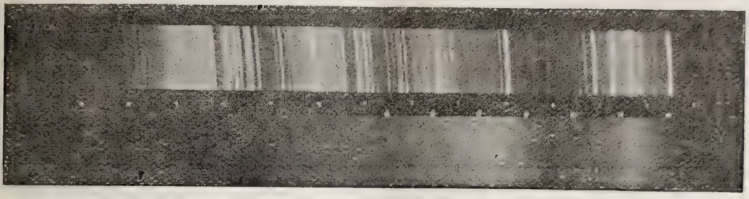


Fig. 5.

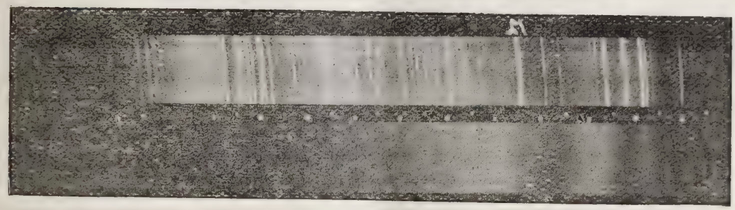


Fig. 6.

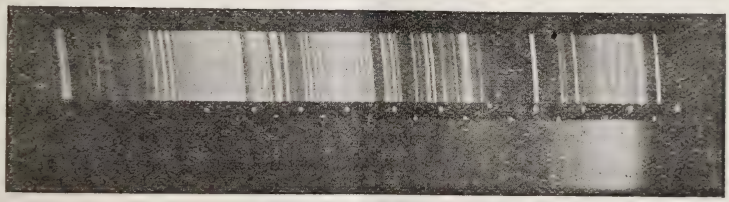
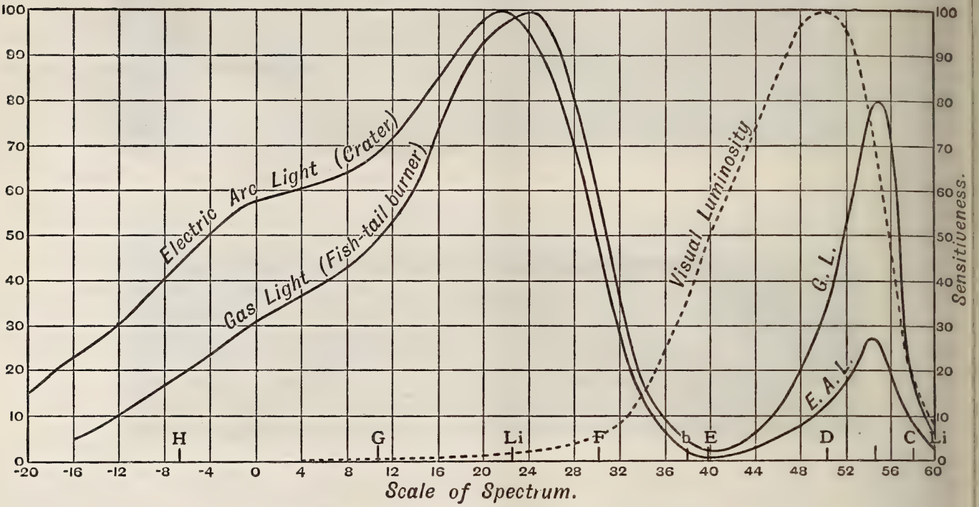


Fig. 7.

In these diagrams the sensitiveness of the plate to the gaslight, and also the electric arc-light spectrum, is shown graphically, and the curves are very instructive. It will be seen that in the former the plate is relatively much more sensitive to the blue than the latter, but in both cases the amount of this part of the spectrum to be cut off is enormous (Fig. 9).

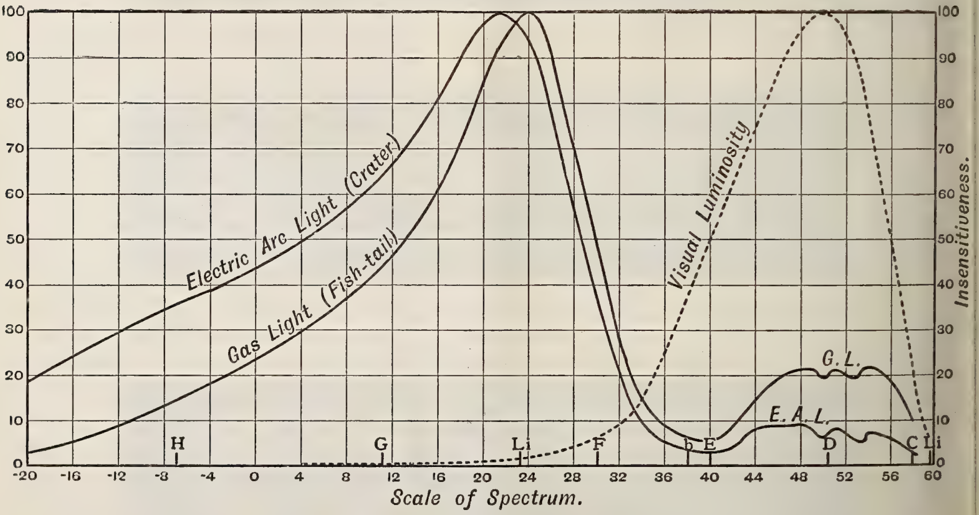
FIG. 8.



LUMIÈRE'S RED-YELLOW SENSITIVE PLATE.

[The author explained the mode in which the sensitiveness to different parts of the spectrum was arrived at. He pointed out that in these as in the previous plates a scale of opacity was impressed on the plate, from which a curve of opacity was drawn, and from which the relative sensitiveness of the differen parts of the spectrum could be derived.]

FIG. 9.



LUMIÈRE'S RED-YELLOW-GREEN SENSITIVE PLATE.

We can reduce the sensitiveness in the blue by means of a coloured screen placed before the plate or in the beam of light falling on it, but do what you may you can never get over this difficulty of the gaps of insensitiveness. So far there is no plate that I know of extant which will absolutely fulfil the conditions that have been laid down. But by modifying the screens we can make a compromise which will not be very far from the truth, when we are photographing the colours of nature which are not pure colours like the spectrum colours, but which are mixtures from colours from large portions of the spectrum. I will now introduce to your notice a method of attaining this end, which I have already shown before the Royal Photographic Society.

First of all we must have a plate which, while sensitive to blue, must also be sensitive to some green - yellow, and red, and if there are gaps we must do the best we can to eliminate their effect. If we can photograph correctly the light which is transmitted through a ruby glass, a green glass, a blue glass, and a white glass, we may take it that any intermediate colours will not be very incorrectly rendered, because each of these coloured glasses transmits a considerable portion of the rays on each side of the colours of the spectrum which most nearly match them. Thus the red will transmit red and yellow, the yellow, red, yellow and a little green, the green yellow and blue as well as green, and the blue glass will allow some green, a little red, and a large proportion of blue to pass. The question arises how can we best arrive at a solution of this problem in a simple manner. Suppose we reduce the luminosity of the light passing through these glasses to a common luminosity, say, of the darkest, then if we have a colour correct plate, we shall have all the densities of a negative when exposed through such glasses equal.

I have had such a screen made as you see thrown on the screen, and measured the light coming through each square, and then cut out sectors (which can rotate in front of them), and cut off the light to the angles to give equal luminosity. We can place a plate behind such a screen and expose it to the same kind of light as that in which they have been measured with these sectors rotating in front of them. In no case will a plate show squares of equal density when exposed behind the colour sensitometer. Suppose we find that the squares exposed through the blue and white show greater density, evidently we must cut off, by a yellow screen, some of the blue. We can cut off red by a green screen, and we cut off green by a red screen. We can guess what depth of each we shall require, and make an exposure with these screens in front of the light, and then see what further alterations are required. We can go on making alterations in the screens till the density under all squares are all the same. In the paper given in the Photographic Society, I fell into the mistake of thinking that the blue square might be omitted, and that the white square would replace the blue square and yet be correct for white. I may say that with the greater part of the experiments I had made, I had a blue square; but in my anxiety to simplify the process, I simply gave a yellow or red, a green and a white square as necessary. This was wrong for some purposes, since the white might be equally well taken to represent the red, the yellow, and the green. Mr. Cadett, who has used this colour sensitometer, found that he got results which were not absolutely correct with his plates. They were plates which I had not yet tried, but which I shall show presently. He is not satisfied that my original proposition to omit the blue square was not correct, but I am satisfied in my own mind that it was an omission, so I have reverted to my original colour sensitometer, which includes the blue square. I show some photographs which give equal sensitiveness to the four squares. Some are commercial plates. Amongst them are plates which do not profess to be sensitive to the red, and, I may say, that no variation, at all events within practical limits, will make the red space show with the necessary density.

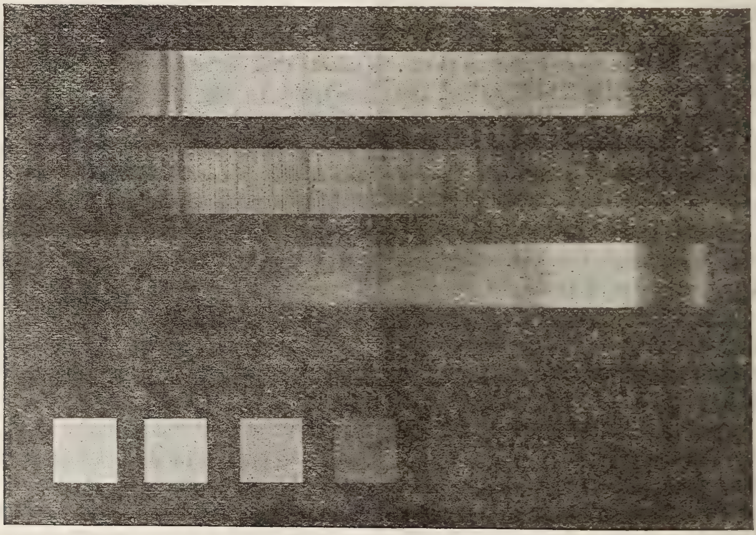
Mr. Ives has shown that an ordinary plate may be made orthochromatic by using coloured screens, but the example he gives of the time of exposure required is not of such a character that makes it appear desirable to use ordinary plates for such a purpose. He gave, I believe, five minutes exposure with such a screen, when the ordinary exposure was only "cap off and on," or say half a second. This would mean a prolongation of the exposure some 600 times. The truth is this, that any plate which, by any amount of exposure, will give a deposit when acted on by the red part of the spectrum, may be made orthochromatic, more especially if the sensitiveness is gradual. If the sensitiveness to the red is, say, $\frac{1}{1000}$ that of the blue, and that the sensitiveness goes gradually down from blue to red, it is only necessary to cut off 999 parts of the blue to bring it to be but as active as the red, and so on for the intermediate colours.

As Mr. Ives has pointed out, and as I myself have often done, a good deal of reflected light from colours, is white light, and this reflected white light will diminish exposure to a considerable degree.

I must point out before I close that I have had the honour of being a judge within the last two years in a competition for the reproduction of a picture in correct colour values, and it has been extremely interesting to have had the privilege of carefully examining the various negatives submitted by the competitors, and also the prints. The last of these competitions was one inaugurated by the Society of Arts, and the subject to be reproduced was the "Choosing of the Wedding Gown," a picture which is the most parti-coloured of any that I have come across in South Kensington Museum. There were a good many excellent negatives and prints sent in; and although none were absolutely perfect, yet there were several in which the colour values were rendered with great closeness. The prints and negatives, I think, were on exhibition at thes rooms, so that I need scarcely refer to the further. I have mentioned these competitions however, to show that we have gone a lon way in advance since the time when a dee black in a print did duty for the brighte yellow or a red in a picture. The questio is, Have we anything more to learn in th direction? I think we have: we have y to make an exact copy of the spectrum i black and white, which in a print shall rende every colour in its correct luminosity.

Mr. Cadett has gone a long way towards i but he has still something to do. Fig. 1 shows in the top band a spectrum of sunligh taken with a wide slit to fuse together the line which are seen in the second band which i sunlight taken with a narrow slit. (It was manifestly impracticable to measure a spectrum containing such an infinity of lines as this shows.) The third band is the gaslight spectrum. The shaded squares at the bottom are the exposures made to get a known scale of density. Mr. Cadett's curve, as you see, is not yet smooth enough, and his sensitive salt is yet too sensitive to the blue. Of course, too, there is rapidity to be attained, and of such a character as can be attained by the ordinary process.

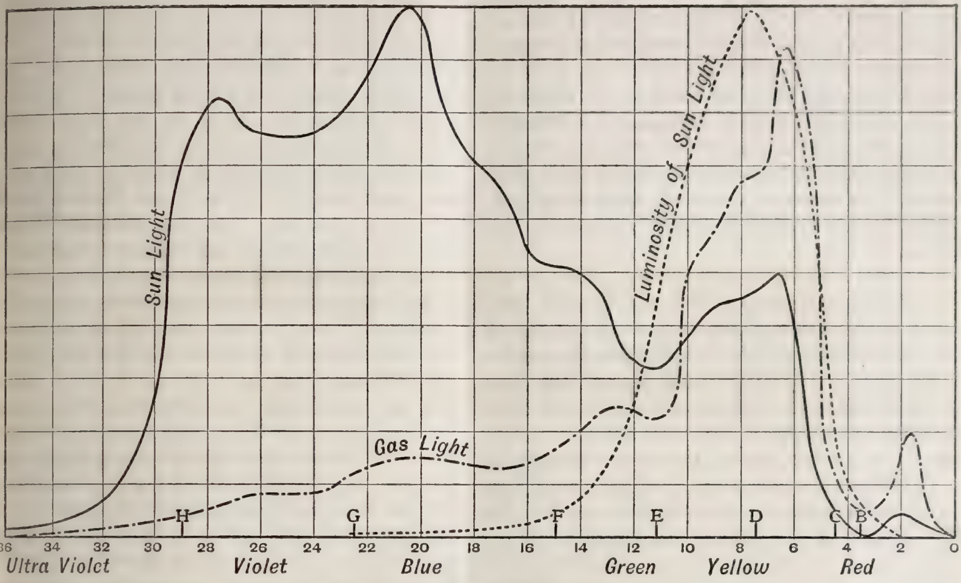
FIG. 10.



We have in the diagram, Fig. 11, the measures of sensitiveness of the Cadett spectrum. The continuous curve shows the sensitiveness to the spectrum of the sun, the big dotted line that to the spectrum of gaslight, and the small dotted line the luminosity of sunlight to the spectrum. It must be recollected that the first two curves mentioned are the curves of sensitiveness of the plate to the different rays. If the plate were perfect the sun's first continuous curve should lie upon the luminosity curve; but it will be seen that it lies mainly far outside it, and had the curve been drawn so that the maxima in the yellow coincided, the part outside would have looked like a great mountain overshadowing a small hill. Evidently then a great deal of the sensitiveness had to be cut off from the blue, violet, and green, before it all approaches the luminosity curve. This cutting off by screens must mean an enormous loss in general sensitiveness. I shall not say how much. Even the gaslight curve lies well outside the blue. At G, for instance, the luminosity is about ·6, while the gaslight curve would indicate a luminosity of 12, or it is 20 times too sensitive to the blue at that point, though at the yellow the maxima are not far off one another. A screen to cut off the blue from gaslight would not, however, by any means mean the same loss of general sensitiveness that it would with sunlight.

I am afraid I have not thrown any new light on orthochromatic photography by my remarks to-night. All I have endeavoured to do is to bring before the Society its present state, and if I have done so, I shall not have come before you in vain.

FIG. 11.



CADETT'S SPECTRUM PLATE.

DISCUSSION.

The CHAIRMAN said that Captain Abney had given in a short time a large amount of information on a subject of extreme importance. He had laid great stress on the scientific side of the subject; but it was pretty clear that the real interest of the work he had brought under their notice lay rather on the artistic side. It was on account of the extreme value that this orthochromatic method would have for artistic purposes in the future that researches, such as he had carried out with such extraordinary success during recent years, were of such value. He had been dealing to-night less with the subject of orthochromatic photography itself than with the means of judging whether it was carried out successfully, and it was indeed as a presentation of the method of criticising photographs produced with the object of rendering in black and white true colour values that the paper was of such importance.

Mr. J. CADETT said he must publicly express once more his thanks to Captain Abney for his admirable method of measuring colour luminosities, photographically speaking, for without this method of testing, he would have had very great difficulty in getting even the results he had been able to obtain. The orthochromatic plates he was at present making had one serious fault; they were extremely slow—so slow indeed, that for general work it was almost impossible to use them. For copying paintings in a good light, if used with a proper yellow screen, they produced results which to the eye were faultless. As was shown by the curve Captain Abney had put on the screen, however, the plate was still very imperfect, the blue sensitiveness being much too great. Another difficulty in the manufacture of these plates was this, that if they possessed any great degree of sensitiveness, it was impossible to examine them at all for defects of manufacture. So that though he had been able to increase their speed considerably, that necessitated cutting and packing them up in total darkness, without any examination whatever. The result was that they feared to send out plates of such a character, as the user would have to take for granted whether there was any emulsion on the glass at all. He estimated that if he could raise the sensitiveness of the plates to that of the average plate, they would be fogged in ordinary dark room light in 1-30th second, and in such a short space of time it would be impossible to examine any plate for defects at all. Plates which had a gap somewhere in their sensitive region had this advantage, that if you illuminated the dark room where the gap existed you were fairly safe, but up to the present they had not been able to find a safe light, and so made the plates extremely slow in order that they might be examined by a feeble light. With regard to the blue square he must say he was still of opinion that Captain Abney was correct in his former paper; but he hoped some day to have an opportunity of going into the matter thoroughly with him, and clearing it up one way or the other. He would not presume to set up his opinion against Captain Abney's, but he still thought, until further evidence was brought forward, that the white square in the method formerly described was amply sufficient, though there might be some little practical difficulty, owing to the small amount of blue which you required to make white light, when combined with other colours. He would not venture to speak quite positively, however, until he had gone further into the matter.

Mr. DEBENHAM wished to ask a question with regard to the varying sensitiveness of the eye to different intensities of colour with different intensities of illumination. If two colours, say red and blue, in a darkened room had just about sufficient light to render them equal, would they still retain their equality if the eye viewing them were surrounded by a considerable excess of light which did not fall on the colours themselves? He would also ask how the representation of the spectrum was obtained?

Captain ABNEY said, if the eye were exposed to so much light as to be dazzled, it would not see the colours at all. It was, as he understood it, a question of the mixture of colour with white light; it did not matter whether the mixture took place on the screen or in the eye. If you had 100 of blue mixed with 1 of white, you would not be dazzled; but if you had 100 of white, the eye would be so dazzled that you would not see the blue at all. It would be the same with red and blue. The representation of the luminosity of the spectrum was obtained by using a rotating disc with an opening of a certain shape, the shape being obtained by projecting on the disc the area enclosed by the curve of luminosity. The manner in which this area was projected he explained by means of a diagram on the board.

Mr. F. E. IVES said Captain Abney's method of testing colour plates was so simple, delicate, and accurate, that it seemed to him that it would be very useful indeed to a great many photographers, who liked to make experiments on their own account, but could not very conveniently arrange the revolving disc and templates. It occurred to him that it might be possible to make these test-plates with different squares of coloured glass, and mount them up with a plate, which had been exposed and developed to such a density as to make the resulting squares of equal luminosity to the eye. practical photographers could be supplied with some thing of the sort, it would make it easy for them t carry out these tests with colour screens and plates.

Mr. W. BOUTALL said the last suggestion woul meet a difficulty which had occurred in the practice o many photographers who had to photograph pictures At present a man, who was setting to work t photograph an old master, was under considerabl difficulty in estimating the value of the colours, an some such method as that just indicated would be o great utility to the practical operator. With regard t the progress of orthochromatic photography, the could now obtain results from pictures which wer simply marvellous. Many of the more delicat tones, which years ago it was impossible to obtain were now easily rendered by means of plates whic were in the market. He had seen prints of photo graphs of portraits from the National Portra Gallery, which gave, in many instances, details in th background that it was quite impossible to perceiv in any orthochromatic photographs made only a fe years ago. In one or two cases it had been neces sary for his firm to undertake the photographing o the same picture at intervals and in that way the had an opportunity of estimating the advanc made in the preparation and treatment of thes plates. He had in his office a photograph made som ten years ago, which exhibited in a very remarkabl way the difference between the result obtained by a orthochromatic plate and an ordinary plate from th same subject. It was a yellow bird with dark blu wings, and on the yellow there were very pronounced black markings, which shaded off to a light grey or the under side. In the ordinary plate, of course, th bird was practically a black mass; there was no dis tinction whatever between the body of the bird and the markings; with the orthochromatic plate th result was to give the light yellow as a very light tone to show the texture and tint of the feathers on th bird, to show the markings with great perfection, and at the same time to give the dark blue wings thei proper monochromatic value. In the case of th ordinary plate, the dark blue wings were almost higl light. The two prints side by side gave a very vivid impression of the difference between a photograpl made under present conditions and those which prevailed when ordinary plates only were available.

Mr. R. T. MALLET asked if there was any possibility now, or any hope in the near future, o orthochromatic plates being affected by the contrasting effect of colour. They knew that if they had green and red spots in juxtaposition, the green would appear greener in consequence of the proximity o the red, and *vice-versâ* in consequence of the physiological effect on the eye. But it did not seem probable that, to the eye of the camera, there would be any such effect. Therefore a perfectly orthochromatic photograph would seem to be quite hope less. The colours one saw were not the real colours laid on the canvass, but those colours as affected by all the surrounding colours; however, to the eye of the camera they were the colours really laid on the canvas.

Mr. **Fuerst** said he had never listened to a simpler statement of the proper method of dealing with colours; and the whole photographic world ought to be deeply grateful to Captain Abney for this paper, seeing that the subject was one to which they must eventually pay very great attention, as ordinary plates really perverted colour values altogether. Not only with regard to the copying of paintings was the matter of importance, it also had much to do with the colours in nature. When you took a landscape, or coloured dresses, such as a group of soldiers, you naturally did not get the same results with ordinary plates as you could with orthochromatic.

Captain **Abney**, in reply to Mr. Ives, said he had shown such a plate as he had described at a meeting of the Royal Photographic Society; but he preferred leaving their preparation to more practical people. He might go into a long disquisition on the subject of contrast colours, to which he had paid a good deal of attention, but he would only say this, we saw black and white with our eyes, as well as colours, and the effect of contrast was very marked in that case. Black looked blacker, and white whiter by contrast with its opposite, so that you had the contrast in monochrome exactly as you had with colours; and the contrast would be shown in a proper orthochromatic plate in pretty nearly the same ratio as it was shown in the colours themselves. He had worked a good deal on contrast colours, and those which were interpretable in black and white, and he had no fear that there would be any falling off in the value of a picture owing to the contrast colours not being reproduced. He had had great satisfaction in listening to the discussion, and should be glad to have half an hour's argument with Mr. Cadett some day, when he hoped their difference would be adjusted. He thanked Mr. Fuerst for his remarks, and was very glad to find that his labour in preparing the paper had not been entirely thrown away. He did not pretend to have told them anything particularly new, but he might perhaps have put the matter in a way which was somewhat novel.

The **Chairman** then proposed a cordial vote of thanks to Captain Abney, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

THE PROSPECT OF THE CURRANT CULTIVATION IN THE MOREA.

It is well known that the currant crop is the staple product of the Morea, and the British Consul at Patras says that the prosperity of the entire district depends upon it, but unfortunately the Morea, like many other countries, appears to be suffering from over production. In order to meet the almost unlimited demand from France for wine-making purposes, some years ago, an enormous area was planted with currant vines, and the crop within fifteen years has been almost doubled. The French vintage having to some extent recovered, and heavy import duties having been imposed on currants entering, the French demand has been almost entirely lost, the consequences being that 30,000 to 40,000 tons of currants are annually produced over what is required for the world's consumption. With an article like currants whose consumption for eating purposes only increases very slightly, however low the price may be, it will readily be understood that such an enormous annual surplus over and above requirements has completely demoralised trade in the article, and brought down prices to a figure which scarcely covers cultivation expenses, and it is evident that if this state of affairs lasts two or three years longer, most of the currant plantations will have to be abandoned, and a once thriving community will be brought to utter ruin. It has been said by some that matters will in time right themselves, that the fittest will survive until the day when supply, owing to the abandonment of these vineyards by the weaker, is not out of proportion of the demand. This argument, which might apply to other crops and industries in other lands, is fallacious in the present instance. It must be remembered that the currant growers, in order to increase their production during the years of unlimited demand and high prices, had recourse to loans at very high rates of interest on a mortgage of their property, and this they were easily able to repay during the years of the French demand, but instead of endeavouring gradually to repay these loans out of the great profits they were then making, these latter were employed in forming further plantations. But the crisis came rapidly. The cessation of the French demand caused prices to drop 50 per cent., at once property lost nearly all its value, and although the growers have been fighting manfully, hoping against hope for the last three years, they are now at the end of their resources, for capitalists who have, in their own interests, been endeavouring during these hard times to support them, find themselves no longer able to do so. Therefore, the currant industry in the Morea is doomed unless some new outlet for the sale of currants were suddenly to be found, or some other expedient were devised.

Could the currant growers all agree to uproot one-third of their plantations the whole problem would be solved, but unfortunately this is is an impossibility. Strange as it may appear a currant crop of 130,000 tons, which is about the amount required for the world's consumprion, would realise over £2,000,000, whereas a crop of 170,000 tons would bring in barely over £1,000,000. The whole question has occupied the serious attention of the Greek Government.

On the subject of the growth of the Sultana raisin, it is said to be a great pity that the currant growers do not pay more attention to the cultivation of this small seedless grape, which is yearly growing in favour in all markets of consumption, and is in many cases taking the place of the currant. More care and expense is required in the cultivation and preparation of the sultana. Still prices obtained are more than double those realised for currants, and amply repay the producer.

DRYING FRUIT, &c.

The following information, bearing on Mr. Badger's recent paper before the Society, is extracted from "Packard's Almanac" for 1896:—

In the western part of the State of New York something like 1,500 tons of fruit alone are dried in evaporators, the greater portion of which are sold for domestic use in the United States. From Australia and Canada large quantities are now annually imported into the United Kingdom.

The first fruit driers were probably invented in America in 1867, and since that date at least 2,200 evaporators have been constructed, and are in use in one of the counties of the New York State alone, and some of them are on a very large scale.

Naturally the first object of the fruit farmer is to supply the markets with fresh fruit, whilst the price obtainable remains remunerative. Professor Baily, the Director of the Horticultural Division of the Agricultural Experiment Station of the Cornell University, U.S.A., reporting on this subject on August 31st, 1895, writes as follows:—"After all is said and done, how much of his crop shall the grower evaporate? When the market prices go below what is remunerative the fruit goes into the evaporator. An efficient evaporator upon any place, even though it be a very small one, has a good effect both upon the market and upon the grower. It keeps a surplus of green fruit off the market, and it informs the buyer that he must keep his price above water level or he cannot get the fruit. On the grower's part it makes him in a measure independent of the market; but more than that it leads him to save much of what is generally a waste product, such as windfall apples, surplus berries, and the like. It is unquestionable that much of the prosperity of this part of America is due to the garnering evaporators, which are the property of so many farms."

General Notes.

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Lisbon Exhibition, 1897.—In connection with the reference in the last number of the *Journal* (see p. 586), it may be noted that Mr. M. M. Bhownaggree, M.P., C.I.E., asked the Secretary of State for Indi in the House of Commons, "whether he has a information regarding the projected Exhibition to held in Lisbon next year to celebrate the fourt centenary of Vasco da Gama's discovery of the rout to India; and whether the Portuguese Governme has invited England to take an important part in th Exhibition; if so, whether it is intended to comp with such request?" Lord George Hamilton reply to the question was that he had not receive any intimation.

Tennessee Centennial Exhibition, 1897.—An Exhibition will be opened on May 1st, 1897, Nashville, Tennessee, for the purpose of celebratin the 100th anniversary of the admission of the stat of Tennessee into the Federal Union. A copy of note from the United States Ambassador at th Court has been received from the Department Science and Art, through the Foreign Office, enclosing a copy of a communication from the executi officers of the Tennessee Centennial Exhibitio inviting Her Majesty's subjects to take part in t Exhibition. The Exhibition is not under the auspic or patronage of the Government of the Unite States.

MEETINGS FOR THE ENSUING WEE

Tuesday, May 26...Royal Institution, Albemarle-street, W 3 p.m. Prof. T. G. Bonney, "The Building a Sculpture of Western Europe." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Tec nical Meeting. "Apparatus for Photography Small Plates (smaller than quarter plates)."

Wednesday, May 27...United Service Institute, Whiteha S.W., 3½ p.m. Rev. T. G. Lawrence, "Recogn tion of Belligerency considered in relation to Nav Warfare."

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 20, Hanover-square, W 8 p.m.

Thursday, May 28...Chemical, Burlington-house, W., 8 p. Professor P. Phillip Bedson, "Lothar Mey Memorial Lecture."

Royal Institution, Albemarle-street, W., 3 p. Dr. R. Munro, "Lake Dwellings." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W 8 p.m. Mr. Alph Steiger, "The Utilisation Water-power, especially with a small fall, wi some Examples of Plants for the Generation Electrical Energy."

Friday, May 29...United Service Inst., Whitehall-yard, S.W 3 p.m. General A. B. Tulloch, "The Highlan Rising of 1745 from a Military Point of View."

Royal Institution, Albemarle-street, W., 8 p. Weekly Meeting, 9 p.m. Mr. Augustine Birrel "John Wesley: Some Aspects of the Eighteent Century."

Saturday, May 30...Botanic, Inner Circle, Regent's-par N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p. Dr. E. A. Wallis Budge The Moral and Religious Literature of Ancient Egypt." (Lecture I

Journal of the Society of Arts.

No. 2,271. Vol. XLIV.

FRIDAY, MAY 29, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening, 17th June.

Each Member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be published in the *Journal* later on.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society.

Papers submitted for the prize must be sent o the Secretary on or before 1st of October, 896. Each paper must be typewritten, and bear a motto, the name of the writer being nclosed in a sealed envelope with a similar motto. The judges will be appointed by the Council.

The Council reserve the right of withholding he prize or of awarding a smaller prize or maller prizes, if in the opinion of the judges o essay deserving the full award is sent in.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 5th, 1896; Sir Saul Samuel, K.C.M.G., Vice-President of the Society, in the chair.

The paper read was—

AUSTRALIA'S PROSPECTS IN BRITISH MARKETS.

By James F. Dowling.

Special Correspondent of the *Sydney Morning Herald.*

In July last, when engaged in my ordinary employment, which is that of writing articles on agricultural and mining subjects for the *Sydney Morning Herald* and *Sydney Mail*, I was specially commissioned to visit England and report upon the prospects of Australian produce in the markets of Great Britain. During the course of this work, which was performed between the 21st of August and the 1st of December, I was honoured by an invitation from your Society to read a paper which would, in a brief way, give the impressions formed in the course of my investigations; but, as it was found that the Session of the Society would not commence until after my departure from England, it was arranged that the paper should be written at sea, and, when completed, be placed at the disposal of the Council of the Society.

An experience of forty years' pastoral and agricultural work in Australasia enables me to gauge, with a certain degree of accuracy, the resources of Australia. They are of immense proportions; but of what use are a good climate and a rich soil, if the millions of acres from which produce of the best kinds can be taken are not brought in a direct and profitable connection with reliable sound markets? Select New South Wales, the mother colony of the Australasian group of colonies, as an example of resources as compared with utilisation. Here is an immense country, 680 miles in length and 760 miles in breadth, with nearly 200,000,000 acres of soil, one half of which is arable, with a climate known to be one of the most temperate and uniform anywhere experienced, unable to export more than about to the value of £14,000,000 worth of pastoral or agricultural products, although the home consumption is only that required for about 1,250,000 people.

Thus, it will be seen that the worth of produce raised is at the rate of 1s. 5d. per acre.

It may be said that this mother colony keeps about 60,000,000 sheep and 2,000,000 head of cattle, but, through not having obtained markets for minor productions, does very little more, in an agricultural sense, than export wool, hides, and tallow. She has millions of acres suitable for the production of wheat, but does not grow sufficient bread-stuffs for her population. She has not more than about one acre per head under cultivation; her wine-growing industry is nearly 100 years old, but has now no more than about 8,000 acres under grape vines. Other divisions of Australia present similar instances of large resources unutilised, but none much more glaring than what are noticeable in connection with the mother colony, New South Wales.

It is the markets which Australia requires. Give the Australian the market, from which he can derive a fair share of profit on his capital and enterprise, and he will work quite as ably and energetically as other people of the world. He produced wool, and finding that he could sell it, has almost worked the wool trade to its limits. He has not been backward in exporting preserved meats, hides, and tallow; but when he goes outside of these, and would supplement his income by returns from frozen meat, wine, timbers, grain, live stock, and several other products, all well within his scope, exported to other countries, he is beset by many difficulties. He is more than 12,000 miles away from Great Britain, which is the chief market of the world. He has a lengthy, expensive sea trip to contend with, and the keen business men of other nations to thwart such efforts as he makes to obtain a footing in various parts of the United Kingdom.

Australia has mastered what art is required in making markets for wool. In 1894 the United Kingdom imported 699,504,672 lbs. of wool; of this quantity there came from Australasia 502,202,500 lbs.; therefore, it may be said that what remains for Australia to do is to keep up to the test of quality in the wools grown, to keep pace with the change of fashions, and the consequent variations in the requirements of British manufacturers, and the wool exports of Australia will go on increasing. Wool is shown, sampled, and sold in London, as perfectly as the best friends of Australia could wish for; and the same remarks may be applied to the way in which Australian hides and tallow are treated by the British brokers and their friends the buyers. In these lines of production the Australian pastoralist or farmer is well safe-guarded, through the fortunate circumstance that the demand for his produ is almost universal. He is not complet dependent on the British markets, as he is the case of other kinds of produce. Wo hides, and tallow are sold in Australia buyers who go out there from many poi of the world with the special object of pu chasing them. When the producer dee his local markets unsatisfactory, he shi to Britain, and the produce is carried at lo rates of freight and under other conditio which are equally satisfactory.

What Australia now wishes to do is to pla her frozen meats, live stock, wines, butt poultry, pork, rabbits, hares, and timbers positions as sound as those occupied by h wool, hides, and tallow.

That there are great difficulties in the wa all of which will have to be surmounted befo Australia accomplishes this desire, must plainly evident to all persons who take interest in Britain's trade. The Australi exporter of these comparatively new lines meeting with much opposition, and as present circumstanced, needs some sympath Take the case of his efforts to send fat catt and sheep to Britain, the efforts to open th new trade were of the most praisewort kind. A few shipments, all of a small kin ranging from 17 to 100 heads of cattle we made on the decks of good cargo steame bound by various routes to England. It wa found that the stock withstood the voyage thirty days fairly well, and, in the case of th earlier shipments, fair rates of value we obtained for them. The freight on catt ranged from £6 to £8 per head, and the ex penses, such as for fodder, insurance, attend ance, &c., brought up the cost of landin an Australian bullock in London to £14 pe head. There was not much of a margin o profit before the shippers, but it was know that if an Australian bullock which woul dress, say, 800 lbs., would sell at 5½d per lb. there would be no loss on the trade. Some thing lower than this might have done, fo it was known that if a bullock which dresse 1,000 lbs., or more, brought 4½d. per lb., th shipper would not sustain loss. The experi mental shipments encouraged a regular trade and at length reached the trial of a full shiploa of 550 cattle, 488 sheep, and 29 horses. This was nothing more than an experiment on a large scale than had been before attempted. The voyage was a lengthy one around Cape Horn, in the worst season of the year, July and August, and about ten per cent. of the cattle and sheep died, or being weak, were killed and salted down on board. The steamer landed her cargo at Deptford, and, as an unprejudiced observer, I can say that the hostility displayed to the first large cargo of live cattle from Australia was of a most remarkable character. The cattle were of very fair quality, and had been fattened on the high lands of Monara and other well-grassed healthy districts. More than three-fourths of these cattle were in good marketable condition, excepting that a voyage of about 60 days had rendered their hair a little rough and grimy. A few were bruised, and one-fourth of the shipment had lost much flesh, and were not more than ordinary store beasts. These latter were stigmatised by a section of the London press as "Scarecrows," and so much was spoken and written against the stock that the Society for the Prevention of Cruelty to Animals thought it necessary to protest against allowing further trial shipments of the kind. I can say that I never in all my experience remember an event which caused the expression of more nonsense than this *Southern Cross* shipment evoked. Writers who had never taken the trouble to visit Deptford or Birkenhead, to learn something about the live cattle trade, had a fling of invectives against this shipment from New South Wales. What was overlooked was the fact that the cattle were well accommodated and well fed; that each bullock had 27 feet of superficial space, the allowance being 9 feet by 3 feet; and that the interior of the ship was perfectly clean when she arrived at Deptford. There were no pains taken to afford a comparison between the Australian shipments and those from the United States, Canada, and the Argentine Republic. The space allowed to a bullock shipped from the States is 8 feet by 2½ feet, in all 20 feet, or 7 feet less than what were given in the *Southern Cross*; and I may venture to observe that for three weeks prior to the arrival of the *Southern Cross*, I saw cattle arriving from America at Deptford in much worse condition than did three-fourths of the stock from New South Wales. I saw cattle from the Argentine so poor and so weak that they could barely creep along. Poor wretched objects which would not be classed as fourth-rate stores in Australia. Nor did the writers who so mercilessly criticised the Australian cattle bear in mind the fact that Britain was importing from various countries about 500,000 sheep and 500,000 cattle each year.

I do not indite these remarks with the object of encouraging the live stock trade. I regard it as a most wasteful system of sending food to Britain. Surely science has placed us far ahead of the necessity for shipping live stock for food. We can send beef and mutton either in a chilled or a frozen state. My remarks upon the criticisms regarding the *Southern Cross* shipment are intended as nothing more than an illustration of the opposition all pioneers of trade have to encounter.

This leads me directly to the prospects of the frozen and chilled meat trades. I think my hearers or readers will readily agree that the shutting down of the import trade in live stock would materially benefit Australia. It would not bring much inconvenience to the consumers of meat in Britain. To them, it would merely mean a diversion of taste, and I have yet to learn that Britons would suffer serious inconvenience if the importation of cattle and sheep for food purposes were completely stopped. The flesh of good healthy animals, killed close to their pasture, in Australasia, or any other part of the world, should be better food than what would be obtained from stock bruised and fevered by short or long journeys in ships or railway trucks. At the recently held dinner of the Glasgow United Fleshers Society, the chairman spoke of the Irish cattle trade as a disgrace to the 19th century, "the cattle in their transit across the channel were almost invariably bruised and the flesh rendered dark. The losses through this cause were estimated to be not less than to the value of £500,000 per annum!" Is there not immense waste here? It is one of the reasons I have for stating that the carriage of live-stock great distances by sea or land is a wasteful one, and although recent shipments of cattle from Australia to England show the loss by death to be no more than three per cent., I specially contend that the future of the meat trade should be on lines which are more scientific and humane than are at present being followed.

That Australia should take a more important share of the trade, incidental to the supply of Great Britain, than at present falls to her lot, must be evident to all observers. Statistics show that England and Scotland require imports of fresh meat from abroad to the value of about £10,000,000, besides which there is the estimate of value of the live stock imported, which is about £10,000,000. The part which Australia is at present taking in the trade is absurdly small. In the nine months ended

September 30th of this year, there were imported into the United Kingdom 1,994,774 cwts. of mutton, and 1,596,970 cwts. of beef. Of the former, New South Wales and Victoria sent 307,122 cwts., Queensland 28,993 cwts.; and of the latter, New South Wales and Victoria sent 86,676 cwts. and Queensland 255,294 cwt. New Zealand had a fair share of the trade, by sending 983,740 cwts. of mutton, and 10,407 cwts. of beef. The River Plate sent 544,253 cwts. of mutton and 17,618 of beef. The most significant feature of the figures is that of the 1,596,970 cwt. of beef imported, 1,215,857 came from the United States of America, which I assume also took the lion's share in cattle importation, for in the year 1894, of the 474,755 cattle imported into the United Kingdom 381,241 head came from the United States.

The exportation of fresh beef from Queensland is progressing most satisfactorily, and as there are about to be tried several cargoes of chilled beef from the same source, it may be said that Queensland is setting a laudable example to New South Wales.

Why the latter colony, which has about 60,000,000 sheep, does not send as much as 1,000,000 carcases of mutton to England each year is one of the questions which cannot be easily answered. Of the 5,000,000 carcases required by England to come from outside sources, New South Wales decidedly should send nearly one-half. It was in New South Wales that the first efforts to export frozen meat from Australasia were made. This fact was not mentioned in the very useful paper on the "Meat Supply of the United Kingdom," by Mr. E. M. Nelson, read to the Society of Arts on March 13th, 1895 (*Journal*, vol. xliii., p. 420).

Between the years 1865 and 1879 the late Thomas S. Mort, of Sydney, spent enormous sums, almost all a fortune made during an honourable career as a merchant, in experimenting with the object of using artificial refrigeration to export and store fresh meat. Prior to establishing his fresh food and ice works in Sydney, and his slaughtering station west of the Blue Mountains, he addressed the pastoraltists in the rooms of the Agricultural Society of New South Wales, and well do I remember having heard his words, "Gentlemen, there need be no more waste." He displayed frozen and chilled meats, and spoke confidently of the future of Australia's frozen meat trade. A large number of pastoralists subscribed sums which reached about £24,000 to assist Mr. Mort in making a trial shipmen and the steamer *Northam* was chosen for tl experiment. The machinery and insulate chamber were put on board, also the mea but just on the eve of the vessel's departu some of the pipes used in the ammonia pr cess burst, and it was found that the tri needed for a time at least to be abandone This was nearly a year before the succes ful shipment of meat was made in the *Strat leven* by Messrs. McIlwraith, McEachern, ar Co.

Thus it appears that although New Sout Wales was the first colony of the Australasia group to attempt the relief of an over-stocke meat market, her efforts of the last 18 yea have not materially swollen her export Prior to my recent visit to England I wa one of the many persons interested in the mea trade, who did not know why it was that th mutton sent from Australia was almost un saleable in England, or at all times stood a low values in the estimation of the Smithfiel butchers. The cause is now as plain to me a the paper on which I write. It is simply tha Australians sent their mutton to the wron part of England. I have a deep and sincer regard for the London market; it does nc receive fair play when required to absorb wha Londoners do not want. London is a great indeed I may say a grand, distributing centre but it is overtaxing its strength when it i asked to give profits on meats which have t be sent hundreds of miles from its meat stalls I was not more than a month in England befor I discovered that the light carcases of merin sheep were the kind of mutton that all th great manufacturing districts of the North o England, and many parts of Scotland, required The sheep breeders of the Argentine Republi were not slow to discover that it was in the North that their chief markets for muttor would be found, and, as you are aware, they have depôts in nearly all the manufacturing centres. The shippers of meat from the United States did not confine their efforts tc London; they promptly went to Liverpool, a port in which half their trade with Britain rests. The Americans are amongst the most enterprising of traders, and in many respects have laid down the lines which Australians should follow. When they mean to attack a market in which there is a fair chance for gain, they go themselves or send well-informed industrious representatives. Very little of their great work in the meat trade is done by agents. As a contrast to this we have the Australians, who seem incapable of doing more than send their meat for sale.

The one man goes with his meat, the other stays at home and grumblingly wishes to know how it is that he does not command large prices for his produce. I believe the Australian shippers of frozen mutton have been expecting their London agents to do what was impossible. It is not fair to ask an agent to establish a trade in what are novel goods. If he did make the trade and create a demand for the novelties, their makers might for some very trivial cause take the agencies from him. What Australians should do is to make direct shipments to the ports of Britain where their meat is required, to establish it in these parts, and then to either employ distributing staffs, or arrange with commission agents to continue the trade.

Liverpool, Manchester, Bristol, Cardiff, and Glasgow are centres in which Australian frozen and chilled meats, butter, rabbits and hares, pork and pouitry, are likely to command fair remunerative prices. If I had the ruling of Australian exports, I would not send even as much as a carcase of merino mutton to London; I would, however, send there cross-bred mutton, butter, fruit, wine, and cereals, and would be careful to have a fair chance of sale for such produce before sending them. I would have the products mentioned sold, just as wool, hides, and tallow are at present sold, which is by auction, and if there were not proper depôts in which the produce could be stored and displayed for sale, I would provide them. To place Australian export trade on a firm base, I would strain every nerve to bring about the united action of all the Australasian Colonies. I heartily agree with the Agent-general for New South Wales when he says that the governments of the Colonies should keep as much aloof from trade as possible; but I do not regard the establishment of depôts as an interference with trade. Municipalities provide market-places, and portions of these or new premises could be leased for the purpose of making Australian produce sufficiently important to have the serious attention of the thousands of traders who distribute produce. These depôts could be made self-supporting, and, if well-managed, they would give to the Australian trade in Britain a tone and a distinctiveness which it does not at present command.

South Australia has established in London a wine depôt on the system which I now suggest, but with this very important difference—it does no more than represent one industry and one colony. How much more probable would be its chance of success and usefulness if all the surplus Australian wines were in its stores?

Victoria has established a collecting depôt for her produce, in which what is intended for shipment to England is stored. The effect of this on the butter-making industry in Victoria has been of marked benefit. But is not the absence of depôts rendered all the more apparent by the good effects of the depôt in Melbourne. So unsatisfactory is the method of selling Victorian butter in London, that not long since there were in that city no fewer than four or six representatives of the shipping companies, each of whom had come to keep a check on the practices of the selling brokers.

Australian producers or shippers will never be satisfied with a market which cannot give open quotations of prices. The greatest fault of the ordinary system is that it does not give open quotations. Australians but rarely express themselves as dissatisfied with the wool market, but complaints about the meat and butter markets are frequently heard.

The auction system, when fairly and courageously conducted is the best safeguard against the action of the rings of monopolists which are likely to be present in all great markets.

I know that my suggestions in respect to auctions for Australian produce prompt the question why should Australia expect more than what is accorded to other countries? Many of the leading commission agents who sell butter and meat have told me that an auction system would certainly fail, but London butchers and provision dealers say that they would be perfectly willing to buy at auction, especially if produce of good or the best qualities were offered at the sales. The best reply to the question, however, may be that the Australian producer who deals with the British markets is differently placed from the producers who make shipments from Europe and America. In the one case, it would take half a year to make a proper investigation of the market; in the other, doubts might be set aside by an excursion of not more than a few days' duration. The Australian has but few opportunities to keep in touch with the British markets, and frequently is victimised by dishonest agents.

I return to Australia strong in the conviction that there is a great future before the Australian frozen and chilled meat trade. I have a great respect for the enterprise and steady business qualities of Americans. They have the courage to make markets and the steady application on sound business principles to keep such markets when they are made. They have shown Australians what should be done; have made beaten ways for Australians to follow. I believe that I am correct in saying that the surplus of meat in America is growing smaller, and will soon completely disappear; also that meat is frequently sold in England at prices which cannot pay American exporters. It is said that there is in America a big ring who, by exporting at a loss, make meat dearer than it would ordinarily be at home, and that, in consequence, meat in New York is often dearer than it is in London. This is a good game to play so long as the surplus exists, or so long as the ring or rings can hold sway. What is wide from the true principles of commerce seldom bears the force of the incidental wear and tear. Australia must come on even terms with America in the British markets. Place the two on an even plane, and the country which has the smaller population and the greater producing power must gain the premier position. Shall I trespass too much on the commonplace when I say that America has had a very lengthy innings, and may now give Australia a fair chance for a good score. I have been informed that the recent shipments from Australia to Manchester were "blanketed" in the market by some of the Argentine and other agents. Well, gentlemen, the Australians must be prepared to meet opposition of this kind, and it is by the united action such as I suggest that such opponents are likely to be successfully fought.

There are dozens of exports which Australia may successfully ship to England. The meat trade will, when it attains its proper proportions, carry several small branches with it. Who would have thought that it was possible for Australia to send as much as 16,000 tons of butter a year to London, or that at any time, immense numbers of Australian hares and rabbits would be regularly sold in English shops? Yet these things are now accomplished and the trade is gradually but surely growing.

If I were asked, what is the greatest possibility of all these new developments, I would say the sale of pure Australian wine in Britain. It is for this possibility that I make my only plea for sympathy and something more substantial from British capitalists. There are in Australia millions of acres suitable for the production of good wine, and I know of no sounde investment for British capital than in th establishment of large vineyards or wine-grow ing colonies in Australia. Not long since asked one who is well acquainted with Eng land's requirements, what chances there wer for sound well-made Australian wines i England. He replied that immense quantitie of three-year-old wines of the Burgundy typ could be sold. I asked what would be th price which could be obtained in London. H replied, 1s. 6d. per gallon!

Information of this kind can provoke nothin more than a grim kind of smile, but as a matt of fact, there is no chance for Australian wine in England, if the markets are not made fo them by the producers. Without reliabl markets there can be no certain qualities wines. Under the present system of productio in Australia, there is nothing outside of hom requirements which is in the slightest degre reliable. The farmer grows his vines, an makes his wine, and the agent who buys fo export is very uncertain in his offerings. H may pay any price from 1s. to 3s. per gallo or may perhaps suddenly take a notion not t buy at all. No company except one with big capital and skilful managers, can hop to make wine-producing successful, but give such a company and the way would be toward future big dividends. My plan of operation would be to buy, say in New South Wales, on of the large estates on the Hunter and one o the Murray. On each of these I would form vineyard colony. The freehold land need no cost more than £4 per acre. I would hav laid out a central vineyard to be cultivated b the company, and have surrounding this sma farms, each of which would have its pro portion of soil suitable for the grape. I shoul either lease or sell these farms on terms whic would be favourable to their occupation, and would have on the central vineyard a staf of instructors to assist all the workers of th colony by instruction and advice. This i the kind of colony to which Australia fathers would send their sons. I would no expect a return from the vineyard cellar until about six years had expired, and the I would trust to the quality of the wines an the business tact of the directors and man agers to place properly in Britain wines which could not fail to be properly appreciated There is not the capital in Australia to tak up a work of this kind. Australians canno bear the idea of locking up capital for six years without the hope of a dividend. Many

them prefer to make bold speculations on
at are frequently misnamed as gold mines.
I would earnestly urge upon Australians the
actice of a greater degree of self-reliance.
ey are too prone to wait so that they may
e what other people do. They are too much
ven to borrowing, and are frequently taking
necessary advances on their shipments of
oduce. This dabbling in finance often leads
forced sales. What is worse, it places the
oducer at the mercy of his agents. With
e self-reliance suggested there is also needed
proper knowledge of the work in which they
e engaged. Americans are at the top in
eat packing and meat exporting because
ey understand their business. A man may
a very good clerk but a very bad manager
r a canning factory.

Australians say: "Start first, and learn as
u go on;" Americans say: "Learn before
u start."

DISCUSSION.

Mr. **Samuel Lowe** said he regretted very much
at Mr. Dowling was not present to read the paper
mself. He had rendered him valuable services
hen in Sydney, and was a recognised authority in
e colony on agricultural and commercial matters,
it he was sorry to say that this paper did not do
m credit, and he should be obliged in the interests
the colony, and notwithstanding his friendship for
r. Dowling, to criticise it in several particulars. In
me points he agreed with it heartily, particularly
here he pointed out the great resources of Australia.
e was satisfied the Australians themselves did not
alf recognise the advantages they possessed, espe-
ally in the matter of their seasons being the reverse
ours, which gave them facilities in supplying the
nglish market such as no country north of the equator
ossessed. But when Mr. Dowling spoke of the pros-
ects for colonial produce he seemed to have missed
e point altogether. The prospects of Australia in
ritish markets must depend mainly on three things.
irst, the capability of the colony for producing those
ecessities and luxuries which the English public
anted to buy, and about that there could be no
oubt; her meat, wool, and a thousand things illus-
ated it; their apples came here at a time of the
ear when our own were hardly in blossom. Next
me her capacity for selecting and grading her
roduce, and placing it on the market in such a
ape as to be most acceptable to the customer;
must be sent in such way as to meet the
nglish taste. Here again he saw no reason why
English-speaking race in the southern hemi-
here was not as capable of doing this as any
ther nation. The third point was, could Australia
place these things on our market as cheap or cheaper than her competitors. Again the answer must be in the affirmative. In her wool, frozen meat, butter, and every industry she had undertaken, she had shown that she could under-sell the foreigner. Latterly there had grown up a supply of poultry, rabbits, and game, specimens of which were exhibited in the library by Mr. Tabor, who would, no doubt, say something about this branch of the trade, and he would therefore pass it over. Australia, then, combined the three essential points necessary for success in British markets. But running through the paper was a strain which seemed to characterise all the views expressed in Australia with regard to the English markets; people came here to investigate and went back, all expecting one thing which was best expressed by the word sympathy. They came here to sell beef and mutton, but they wanted sympathy as well. Mr. Dowling carried it so far, that he wished the English people to change their tastes. As an instance of want of sympathy, he felt aggrieved that the British farmer and gentlemen connected with the land objected to what they looked upon as a new enemy, and that they did not like the introduction of live cattle, as tending to lower prices. The feeling was quite natural, and Australians would probably regard fresh competitors of their own in much the same light. In fact, they did not, by their tariffs and shutting out English manufactures, show much of that sympathy which they desired to receive. But he (Mr. Lowe) could not agree that the shipment of cattle by the *Southern Cross* was received with hostility; he had seen no evidence of it in similar cases. He must say, however, having seen the cattle put on board in Sydney, that the way in which they were treated was disgraceful, and he wondered the Society for the Prevention of Cruelty to Animals, if there was one there, did not interfere. If the shippers in Sydney had been more humane, the cattle would probably have arrived in better condition. Mr. Dowling suggested that we should stop the importation of live cattle altogether, and said it only required a slight "diversion in taste" to accept frozen meat instead of fresh. That was the weakness of many Australians; they wanted us to change our tastes to suit them. That was not business; the seller must suit the buyer, or he would never make his market. Mr. Dowling referred to the Americans, and said they did not send their produce to be sold by a commission agent, but came here and did it themselves. No doubt that was the better way, but there was no reason for making imputations on English agents, who did the best they could. When they went down to Manchester with a shipment of meat, and did the best they could to dispose of it, the Argentine people lowered their price ¾d. a lb., so that the buyers of Australian meat might lose money by it, and be unwilling to purchase in future. Mr. Weddel said they meant to fight this to the bottom, and would not allow the River Plate people to interfere with Australia's markets; but when his remarks

reached Australia several shippers wrote, "Who is going to pay for this fighting? We are not." It was said again that the Americans sold their meat here at a loss, and that it paid them to do so, because they could make a better price at home; but Mr. Dowling would not recommend his friends in Australia to do the same. He did not believe a word of it. Of course, losses might be incurred by the American shippers, as by the Australian, but it was not done as a matter of policy. Mr. Dowling put the matter on the right footing further on, when he said the Americans were at the top of the tree with all kinds of canned meat, "because they knew their business." Australia had sent over preserved meat for years, but there was the greatest difficulty in disposing of some of it, because it was badly prepared. The competition of America was not on the question of price, but of preparation and appearance. Mr. Dowling said the great thing the Australians wanted was a market, and he referred to New South Wales exporting only £14,000,000 in a year, which he thought was very small. But it was above £11 per head of the population, whilst the exports from Great Britain were only a little over £5 per head. What they really wanted were more workers. Australia had immense resources undeveloped; and until she increased her population to 20, 30, or 40 millions she would never take the position she ought. It was a miserable policy to try and produce great quantities of exports with a small population. This led to going back to the primitive system of wool growing, because it required less labour than almost any industry in the world. Mr. Dowling was in favour of sales by auction because that system had been found satisfactory with wool, hides, &c.; but it had been tried with other things, apples from Tasmania, for instance, with very little satisfaction to the shippers. Selling goods by auction was all very well when the demand was strong, and they were not perishable, but anybody could sell a thing when there was a good market; when the market was drooping, then auction prices were ruinous. Not long ago a shipment of frozen Canadian salmon was sold by auction in London, and was a good illustration of a "knock out;" it was sold to a few Billingsgate fishmongers at 1½ lb., and was resold at prices ranging from 4d. up to 9d. Not once throughout Mr. Dowling's paper was any reference made to the quality of the goods; but if Australia were more careful to send only the choicest quality she would have no need to complain. With regard to merino mutton, he agreed that the north country people did like a small sheep; so do many in London. It was absurd for Mr. Dowling to say he would not send "a single merino sheep to London." Why should he restrict his market? If Australia would produce the best articles, prepare them as our people liked, and put them on the market as cheap as other nations, her prospects would be as bright, aye brighter, than anyone's, for English people would rather buy of their own kinsfolk than of a foreigner.

Mr. H. MONCREIFF PAUL said he also regretted t
Mr. Dowling was not present, and felt a delic
in criticising the paper in his absence. He was an
colonist and pastoralist, and he must say it wa
mistake to call Australia an agricultural count
to a large extent it must always be a mining
pastoral country. An agricultural country requi
abundant moisture, and to secure this in Austr
it was requisite that there should be a large devel
ment of irrigation, which would be costly. A
from that, as had been pointed out already, colon
in seeking to establish markets for their produce w
apt to make the mistake of rowing against the stre
instead of with it. There were markets in Gr
Britain for all kinds of produce, if it was o
allowed to run in the ordinary channels, but colon
seemed to want it to be disposed of in so
other way. The two leading features in the pa
were (*a*) the advocacy of the auction system, and (*b*)
need for a special organisation for the sale of colo
products outside the usual mercantile agents. W
was cited as an instance of the former. The succes
the wool trade was not, however, due to the auct
system, but because Australasia produced a class
wool which could be obtained nowhere else;
world could not do without that wool, and tool
most readily, and in order to dispose of it most
vantageously the auction system was employ
There were serial sales held throughout the year,
which buyers from all parts of Europe and Amer
attended. Every bale was shown, and buyers boug
from an inspection of the bulk, not from samp
This could not be done every day, and, therefore,
auction system was found convenient, and it had
great advantage that it kept the Colonial wool tra
free from the trammels of gambling in futures. He w
sorry to say that Argentine wool stood in a differe
position, and did form the basis of speculative ope
tions. Hides, basils, leather, bark, bones, horse ski
shells, tallow, and fruit, were also sold by auctic
because they found their market where similar artic
from other centres of production were also sold, b
that did not prevent their also being disposed
by private treaty. Tallow, when it used to co
from Russia, was all sold by private contract, and
made and lost the fortunes of many people who d
not know one kind from another, but simply dealt
p.y.c. tallow on a c.i.f. basis, and to this day, althou
there was very little p.y.c. in existence, still there wa
speculative market for it. In leather, basils, and pel
many dealers would not go to auction and buy, lest the
opponents should learn the price they gave; they wou
rather buy from factors by private contract. Dai
produce, grain, or preserved meats would never sell
advantage by auction. For corn there was the mark
in Mark-lane, which had its own arrangements, an
when wheat used to come largely from Australia an
New Zealand it was appreciated there according to i
merits. If preserved meats were sold by auction the
were looked upon as damaged to be sold withou
reserve, and many a lot had been sold in that way t

reat disadvantage, which if disposed of in the proper uarter would have made a much better price. Timber 'as more or less offered by auction, but there was a irge business done by private treaty. Timber from ustralasia was gradually making its way, but there gain it was a question of properly preparing it for the iarket. He had known timber come in a condition i which it could not be used, and had to be stacked r a long time before it could be turned into money. Vith regard to frozen meat, he was resident in New outh Wales when Mr. Mort first made his experiients with regard to refrigeration. He had suffered ; most pioneers did. He laboured and other people itered into his labours. Mr. Dowling had forgotten) point out that after Mr. Mort's experiments it was ot followed up by others in New South Wales, ut the industry lay dormant, and was then taken p to some extent in Victoria, but more successilly in New Zealand. Another point in which ie frozen meat industry failed was the basis upon hich the companies were formed throughout the olonies. It was not uniformly that of purchasg meat from the growers and properly grading, icking, and preparing it for the market, but very uch on the basis of allowing anyone to send such meat as they pleased to be frozen, id then shipping it to this country, and there as thus often great want of attention to all the etails connected with such a perishable article, hereas those companies which shipped on their own count were much more careful in these respects. hen again another fault was a desire to emphasise e fact that the frozen meat came from a particular ntre of production, instead of allowing it to me here simply as meat and allowing it to rest i its own merits. There was frequently a sire on the part of one colony to make it perctly clear that the meat came from there, and d not come from any other colony, or from rgentina, and to show that the Argentine people ere selling their meat as New Zealand. This got road, and the domestic servants, who were the asters of the situation, had an idea that this meat is something cheap, and that they must set their ces against it. This had interfered more with the ccessful consumption of frozen meat amongst e middle and upper classes than anything. obody went into a butcher's shop and asked r a Dutch mutton chop, although there were ousands of Dutch carcases from which very nice itton was sold in London. It was sold simply mutton, without reference to origin. If frozen eat had been dealt with all through in the same y, they would not have had such low prices. efrigeration interfered to a certain extent with the sues of the meat, and the process familiar to houselders when the pipes burst after a frost went on to certain extent in any carcase that was frozen, and, erefore, there would never be the same amount of trition in frozen meat as in that not frozen, hough a great deal of this might be overcome by proper cooking. In lambs, which were of smaller bulk than mutton, this effect was not so severe, and frozen lamb presented a much more sightly appearance than the carcase of mutton, whilst, on the other hand, a quarter of beef showed the effects of refrigeration more than a carcase of mutton. Mr. Dowling, in his remarks with regard to merino mutton, showed that he had not thoroughly studied the subject. It need not necessarily be sent to the North of England. In that part of the country there were different classes of people whose wants must be considered. In Manchester, where the operatives were principally employed indoors, they could not stomach heavy fat carcases; but in Birmingham the same would be accepted readily. In developing the frozen meat industry, they must carry the masses with them, they being the great consumers. The upper and middle classes would not consume frozen meat when they could purchase the home-grown article. It had been found by experience that a leg of mutton from a cross-bred sheep went further than that from a merino. The Argentine meat industry was on a much more satisfactory basis in many particulars. It was more concentrated. It was all in the hands of about three companies, who purchased, graded, and shipped on their own account, who knew what to send, and where to dispose of it. They developed the market in Liverpool, because that was the most convenient port for South America, but that was not their only point. They all had agencies in London. The same remark applied to American chilled beef. It came to Liverpool, but special railway rates were arranged for bringing it to London, the Liverpool market not being sufficient. The difference between chilled meat and frozen meat must be borne in mind. The voyage from America was so short that meat could be brought over only chilled, and it occupied a different position from frozen meat. Experiments on chilled meat from Australasia met with a certain amount of success, but the voyage being so much longer, and the vessels having to pass through the tropics, a number of small details had to be attended to in order to insure satisfactory results, and these were not always carried out. With regard to the live stock trade, he thought Mr. Dowling was under a complete misapprehension. In the first place the animals were not properly prepared on the other side to undertake the voyage, then the fittings for them on board were not satisfactory, the food was not always suitable, and the whole arrangements for discharging them here were likewise defective. No wonder the Society for the Prevention of Cruelty to Animals was induced to interfere. He had personally inspected a number of these animals, and found some were fitted for the market, but the others ought never to have been sent. He did not see why the live trade should not be maintained to a certain extent between Australia and this country, but in order to do so it was necessary to have steamers specially fitted up, and the animals coming from the bush ought to be kept for a short time in the neighbourhood of the shipping port and get accustomed to eat fodder before being shipped. With regard to the wine trade again it was a question of details not having had sufficient attention. There was a great deal more to be done before Australian wine could be satisfactorily landed in this market. He did not consider it the province of Governments to interfere with trade, and the idea of the Colonial Governments sending experts here merely to watch over the sale of produce would be childish if it was the fact; but he understood that these experts were sent for quite a different purpose. In conclusion, he remarked that in order to establish a market, it was necessary that shipments should be continuous as far as possible. As their merits became known, their reputation would be established, and on the average results success would depend and assuredly follow.

Mr. C. TABOR said he did not intend to say anything except concerning his own trades, that of poultry and game, with regard to which he had placed several specimens from the Colonies in the room below. There was no opposition to the introduction of Victorian poultry. It had only come to London during the last three years; and for eight or nine years they had had large shipments of Russian fowls, but the moment he had any Victorian fowls to offer he beat the price of the Russian by 1s. 3d. a head, because they were so much better, though they did not fetch as much as English. The colonials were very fond of provincial markets, and thought they were the Eldorado of the trade, but that was a great mistake. If you got a good figure for an article in London it might hold its price in the provinces, but if you sent it to the provinces on commission, in the first place, you not only got such a figure that you dare not return it to the sender, but you might think yourself lucky, in many instances, to get any figure at all. There was no ring in the poultry market; it was a very limited trade; the salesmen did not exceed 100 in London; and if they knew the amount of competition there was for the trade, they would see that no ring was possible. London was the right place to send colonial produce to. It would not all be consumed here, but London was *en rapport* with the provincial towns; and if it would not fetch a good figure in London, it never would in the provinces. When the trade began, nothing seemed too hard for the colonial to try to hold the trade. The first lot even were sent over in cardboard boxes, which were very pretty, but too costly; everything was carefully graded, and there was no fear of anything coming through but the very finest, but as soon as the trade was established it was all changed, and instead of sending the best they did not object to sending the second best and even mixing it with the first if they thought you would not see it. Only that day in opening some crates of rabbits he found in the centre goods that ought not to have passed the examiner and would have been rejected a year ago. Then he found that
having sent him rabbits, for which he obtained 12s
dozen, on commission, they afterwards found out t
markets he sent them to, forwarded them th
direct, and offered them at lower prices. Again
he wrote saying he only wanted a certain supply i
particular time, in a few months he got sent over th
times as many as he said he could use, and at a ti
of year when the trade did not want them. T
auction as applied to the poultry trade was an absol
failure. Not only here but in France in 99 cases out
100 you found bad prices shown for auction sales,
much so that many of the leading factors employe
man who knew the buyers to dispose of their goo
by private contract. The Victorian trade commenc
two years ago last March with ten crates, and t
last ship left on his hand 1,500 crates, and he w
not the only man in the trade. A great thing
favour of the colonial trade in poultry was that t
seasons in the colony were the reverse of ou
There was a particular time of the year wh
English fowls used to be driven up to 6s., 7s., a
8s. each, but the Victorian fowls came over first
that time of year, and put it in the power
hundreds of people to eat that class of food at
season of the year when previously they would ha
been unable to do so. Fowls were at their best
the Colonies when ours were at their dearest.
Victoria, New Zealand, Queensland, and Tasman
they adopted different forms of packing. He mu
preferred the Victorian, and he would hand to t
Chairman photographs of the different kinds
crates employed. From Queensland the crates we
very long and bulky, and awkward to deal with. I
did not agree with the last speaker that it was not
good thing for Government to interfere with trade.
great deal of the success of the Victorian poultry tra
was due to Government interference, sorting, inspec
ing, and providing suitable crates. The goods whi
came from New South Wales were the worst of t
lot. He had had a great many from there, but th
had never made a good price, not on account of t
quality, but because they were so badly packe
They were simply thrown into the boxes without t
slightest care. The Victorian Government took t
rabbits, sorted them into sizes; they were hung
each side of a bar, put inside a crate, frozen, a
never unfrozen until they were sold in Englan
Some time ago a great outcry was made about t
rabbit trade, and it was suggested that the Australi
rabbits were poisoned. The fact was that t
districts where they poisoned rabbits were ma
hundred miles away from Melbourne, and in
country where the normal temperature was over 90
You could not send rabbits over 100 miles by ra
without their going bad. Therefore, all the rabbi
sent to England were collected in an area of fro
30 to 40 miles to Melbourne. He had always foun
rabbits realise exceedingly good prices. The fow
and ducks came in crates containing 14, 16, an
20; rabbits in crates of 48. Those who saw the
directly they were opened, thought they were rathe

d, but after a short time they became perfectly hite. Some people said the freezing made the meat ard, but if so, it was through injudicious thawing. he only bad result was to make the skin a little ard. The flesh was not affected, and there was no ss of flavour.

Sir CHARLES KENNEDY, K.C.M.G., said Mr. owling's paper and the discussion upon it had been ery interesting. He would not enter into details f local management, but considering these branches f colonial trade to be new openings for commerce it ust be remembered that it was of very little practical use to throw new goods upon a market suddenly. are must be taken to watch over the supply when it rrived, and to make arrangements for its disposal. ew Zealand meat had now become well known many country districts in England, and was reived with considerable favour, and there was no ason why the same favour should not be extended Australian meat. The great thing was to secure at capable agents should watch over the goods when ey arrived. Certain firms had taken up the supply f wines from the United States with great success; d some, in like manner, had taken up the sale f Australian wines, which are now becoming nown and appreciated in London clubs. There emed every reason to anticipate a very successful le in the future.

Mr. NIVEN said he thought the previous speakers ad performed a very important service to the ustralian colonists in pointing out their shortmings, and he entirely agreed with the greater rt of the remarks made by Mr. Lowe. He could eak from experience of the undeveloped resources Australia. It was, perhaps, true that Australia as not a specially agricultural country. It was not ecially adapted to agricultural purposes at present, d sufficient efforts had not been made to convert into an agricultural country. On the other nd, the squatters had been allowed to obtain rge tracts of country for a very small sum, d although land had sometimes been thrown en to the free selector at a cheap rate, it was very long way from the market, and it was of no e to him for growing produce if there was no road tween it and the principal markets. Again, there as a large influx of people into the towns, who uld not be persuaded to go up the country and lp the squatter even to look after his sheep. There as plenty of scope for the employment of the whole pulation and many more. He was not anxious at the wine trade should be cultivated for the nefit of any country, seeing that drink was one of e deadliest curses of the Anglo-Saxon race. Apart om that, he had not a very high opinion of the ality of the Australian wine. It appeared to him at this paper was rather too much in the nature of brief held by the writer for the Australians and the ople of New South Wales. It was not a statesmanlike production, and was not up to date in the information it contained. It was of the highest importance to weld together as closely as possible the mother country and all its colonies, and commercial considerations were of some importance in that point of view, but commercial considerations were not the highest considerations. The mother country and the colonies ought to aim at something higher than merely getting pecuniary advantages out of each other. They ought to consider it their duty to promote the intellectual and moral welfare of all the races which formed the British empire.

The CHAIRMAN said he regretted very much that this discussion had not taken place in Australia, because the people there, for whom all this information had been given, would have been much enlightened by it. He did not know that it was much use saying here what the people in the Colonies ought to do; the information ought to be given to the colonists themselves; and some efforts had been made in that way for some time past. The colonists not being quite satisfied, the governments had sent experts to this country with the view to see how the trade could be benefited, but he did not know that they had gone back very much the wiser. Mr. Paul seemed to think that the colonial sheep did not always come here in a very good condition. It was strange if that were the case that there should be a Bill before Parliament for marking meat in order to prevent colonial meat being sold as English. Colonial meat was sold as English and sold extensively, and people were not a bit the wiser. No doubt if servants had an idea that frozen meat was being used in the families in which they were employed, they would rebel against it. It might be that some frozen meat was inferior, but all English mutton was not alike. With regard to grading their produce, no doubt it would be a good thing if the people in the Colonies would grade their butter and meat and everything else and only send their very best; but that would not satisfy the English purchaser. He would not be satisfied with any grading in the colony. He would examine every package of butter to see if it were a good quality before he bought it. With regard to the action of the Victorian Government in assisting these industries, Mr. Tabor had handed him photographs of the crates for rabbits and poultry provided by that Government. No doubt if they chose to provide exporters with these crates they would be able to send their produce in much better condition, but the moment the Government ceased to provide the packages, he feared they would not be so ready to provide them themselves, as the expense would be too great. They would find out in time that they could not sell products unless they were of the best quality, and then no doubt the business would improve. With regard to the shipment of live cattle, the Colonial Governments were very particular to see that none but healthy sheep and cattle were sent away. Australian meat was good, wholesome food; it would find its market in spite of the prejudice which prevailed. If English people consumed Australian and New Zealand meat, and were satisfied with it, why not let them alone. Why should they take the trouble of proclaiming that their meat was inferior? With regard to live cattle, he believed it might have been a good trade, but unfortunately the people in the Colonies did not realise that the cattle were different in Australia to those in Argentina. In that country a great proportion of them were stall-fed a short time before shipment, but in Australia they are brought wild from the bush and driven some distance, and put on board ship to lead lives which were not natural to the poor brutes, and, of course, it would be a serious loss to those who shipped them. They ought to have known better. The ships were not suited to the trade, and going round Cape Horn was a terrific voyage, during which the animals must no doubt have fared very badly, especially as the ships were much overloaded.

A vote of thanks to Mr. Dowling was then carried unanimously.

General Notes.

English Student Teachers in France.—The Department of Science and Art have received through the Foreign Office, from Her Majesty's Ambassador in Paris, a notice from the French Ministry of Public Instruction, that ladies who intend applying for the posts of "répétitrices" in French training colleges, that will be vacant next October, should apply to the Ministry of Public Instruction, not later than June 1st. Terms of application, together with full particulars respecting these posts, may be obtained by applying to Miss Gardner, Newnham College, Cambridge, or to the Secretary, Franco-English Guild, 41, Rue Gay Lussac, Paris.

Brussels Exhibition, 1897.—Information has been received from the Science and Art Department that a Royal decree has been published in the *Moniteur Belge*, applying article 11 of the Convention concluded in Paris in 1883, for the protection of industrial property, to the exhibits at the Brussels International Exhibition, which is to take place next year. The decree provides that inventions capable of being patented, designs, and trade marks shall receive protection during the Exhibition, with out prejudice to the grant of the patent, &c., which may be applied for after the close of the Exhibition. Application for certificates granting these privileges is to be made within a month after the opening of the Exhibition.

MEETINGS FOR THE ENSUING WEE

Monday, June 1...Royal Institution, Albemarle-street,
5 p.m. General Monthly Meeting.

Engineers, United Service Institution, Whiteh
S.W., 7 p.m. Mr. M. A. Pollard - Urquha
"Example of Railway Bridges for Bran
Lines."

Chemical Industry (London Section), Burlingt
house, W., 8 p.m. 1. Mr. W. Gowla
late of the Imperial Japanese Mint, "Japan
Metallurgy—Part I. Gold and Silver and th
Alloys." 2. Mr. Sherard Cowper-Coles, "
Electro Deposition of Zinc."

Surveyors, 12, Great George-street, S.W., 3 p.
Annual Meeting.

Geographical, University of London, Burlingto
gardens, W., 8½ p.m. Mr. J. T. Bent, "Journ
to North-Eastern Soudan."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m

Tuesday, June 2...Royal Institution, Albemarle-street,
3 p.m. Prof. T. G. Bonney, "The Building a
Sculpture of Western Europe." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.
Annual Meeting.

Biblical Archæology, 37, Great Russell-street, W.
8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1.
Charles Davies Sherborn, "Explanation of
Plan adopted in preparing his Index Generum
Specierum Animalium." 2. Messrs. Elwes a
Edwards, "A Revision of the Oriental Butterfl
of the Family *Hesperiidæ*." 3. Mr. P. Chalme
Mitchell, "A Contribution to the Anatomy of
Hoatzin (*Opisthocomus cristatus*)."

Wednesday, June 3...Archæological Association, 32, Sac
ville-street, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.
Professor W. B. Richmond, "The Vault of t
Sixtine Chapel." (Lecture III.)

Thursday, June 4...Royal, Burlington-house, 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. Dr. W.
Perkin, "The Magnetic Rotation of Organic Su
stances, with Special Reference to Benzeno
Compounds."

Royal Institution, Albemarle-street, W., 3 p.
Dr. R. Munro, "Lake Dwellings." (Lecture II.)

Friday, June 5...United Service Inst., Whitehall-yard, S.W
Admiral P. H. Colomb, "The Functions of t
Army and the Navy in Defence of the Empire."

Royal Institution, Albemarle-street, W., 8 p.
Weekly Meeting. 9 p.m. Prof. J. A. Fleming
"Electric and Magnetic Research at Low Temperatures."

Geologists' Association, University College, W.C
8 p.m. Prof. John Milne, "Bradyseisms, Earthquakes, and other Movements of the Earth'
Crust (Geodynamics)."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-square
W.C., 8 p.m.

Saturday, June 6...Royal Institution, Albemarle-street, W.
3 p.m. Dr. E. A. Wallis Budge, "The Moral an
Religious Literature of Ancient Egypt." (Lecture II.)

Journal of the Society of Arts.

No. 2,272. Vol. XLIV.

FRIDAY, JUNE 5, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will be held at he South Kensington Museum (by permission f the Lords of the Committee of Council on Education), on Wednesday evening, 17th June.

Promenade Concerts will be given by the Band of the Royal Artillery in the North Court, nd by the Red Band in the Textiles Court, nd a Vocal and Instrumental Concert in the Raffaelle Gallery. An Exhibition of Moving Photographs will be given at intervals in the Lecture Theatre.

Each Member will receive a card for himself, which will not be transferable, and a card for a ady. In addition to this each Member will e able to purchase additional tickets, the rice of which will be 5s. each up to the day of he *Conversazione*; on that day the price will e raised to 7s. 6d. It is requested that Members requiring these additional tickets will nake early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and ther arrangements will be published in the *Journal* later on.

Cards of invitation are now in course of ssue.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the enjamin Shaw Trust, a Gold Medal, or a rize of £20.

The medal, under the conditions laid down y the testator, is to be given "For any disovery, invention, or newly-devised method r obviating or materially diminishing any sk to life, limb, or health, incidental to any ndustrial occupation, and not previously apable of being so obviated or diminished y any known and practically available eans."

Intending competitors should send in descriptions of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 12, 1896; Sir Owen Roberts, M.A., D.C.L., in the chair.

The paper read was—

WOOD ENGRAVING AS COMPARED WITH OTHER REPRODUCTIVE ARTS, AND ITS FUTURE AS A FINE ART.

By W. Biscombe Gardner.

In the short paper I am about to read, I wish to place before you—first, the many advantages wood engraving possesses over all other reproductive arts; secondly, what I think ought to, and what I think will, be the future fields of this art; and thirdly, to follow up with a suggestion as to a way to arrive at that result. Whether my suggestion will be taken up I must leave the future to determine.

The great power wood engraving possesses beyond all other reproductive materials, I hope to prove, by bringing before your notice the variety of methods of handling the graver which has been resorted to in the production of the specimens that are on view to-night.

Wood engraving, we are told by some people, is dying out, or will be one of the past arts before many years, and process or mechanical work by means of photography will take its place as a medium for illustrating books, magazines, and papers.

This is what we hear on all sides, and if we look at the illustrations at present produced in most of the publications, it undoubtedly does appear at the first glance as if there were something in this almost universal opinion. But what is this so-called popular opinion? I think it only comes from readers who confine themselves to the sensational side of literature, and not having their imaginations fully developed, want something beyond the letterpress to help them to realise what they are reading; *then* cheap art comes in to help the cheap publications, which are on the increase to such an extent that process illustration looks as if it were taking everything before it.

But by dipping a little deeper into the question we find a very different state of things. We see that wood engraving was never more alive as a fine art, or in a higher state of perfection than it is at the present period; and it is still capable, in the hands of right good earnest workers, of being lifted to a much higher position.

We may grant that wood engraving has been superseded for a time, for purposes of illustration, by process work, on account of the latter being so much more rapid, and also much—very much—cheaper. I will not say very much inferior, for it is unquestionably better than bad wood engraving. And here I may say, I do not mean essentially bad work, but work that has to be done in a rush, such as war subjects, which sometimes have to be engraved in a few hours.

Yet so long as the public are blind enough (blindness which makes one wonder, considering the art culture that is going on all over the country) to take bad or rather, as some put it, "soft and delicate" kinds of illustration, instead of good art, both delicate and beautiful, so long will some publishers give them bad rather than good work, charge the same for the publication, and pocket the difference, and why not, if the public will be so foolish? Every opportunity is afforded them to distinguish the good from the bad; but they, or the majority of them, judging from the publications that pay best, prefer the bad to the good. Then, what happens? So long as this blindness or apathy lasts so long will wood engraving suffer in this particular department of publication.

But we have a much brighter side to look at. Let us leave behind the lovers of cheapness and speak to those who are lovers of art for art's sake. To them I say that wood engraving, as a reproductive fine art, never can be touched or ever will be touched by any process yet invented. I am now speaking of all the mechanical processes at present being used for illustration. With regard to the higher or fine art processes I hope to show further on that wood engraving is far and away above any of them in its marvellous versatility of *technique*, which enables the engraver to translate not only the values, but the very individual touch of each artist, from whose picture he may be engraving.

All processes dependent upon photography are bound to go wrong in the rendering of values, since photography has not yet bee brought to such a state of perfection as t master the difficulties of exact colour translation. In fact photography is utterly inadequate in the most simple wash drawings i black and white. For instance, a drawin executed in black, no matter what black, whe Chinese white is used mixed with the black will come out, as a whole, entirely untrue as t values in the process block, because of th brown in the black and the blue in the whit The slightest difference in the admixture of th two colours will be entirely mistranslated although the drawing may look perfectly righ as to the values to the eye.

Even in a pure wash drawing, without th use of Chinese white, the paper drawn upo being more or less yellow, the high lights tha are left are lower in tone in consequence.

Take any process, and if you have an intimate knowledge of the original painting c drawing from which the process plate has bee done, you will see at once how very far short falls of the original. All the spirit has departed from it—it is weak and insipid. Indeed although photography has made great stride in late years, it has not yet been able to ge over its main difficulty, values, and I must sa that I do not see at present how it can ge over it. No process plate that I have eve seen, either from a painting or a black an white wash drawing, has had a pure black, c a properly gradated white, which is as muc to say, it cannot carry out the most simpl rules of translation of values. But, I adm with pleasure, that a pen-and-ink drawing i pure black ink could hardly be reproduced i a better manner than by the best process. say the best, as I only now and again see very fine line reproduced thoroughly well b process. As a rule it is either broken o thicker than the original, and thus loses it value. But beyond this, I most emphaticall assert that nothing does or ever can compar with the work done through the sensitiv medium of the eye and hand of man. I fact, I consider wood engraving far bette than any, or all the reproductive arts, as i stands quite alone in its wonderful adaptability; for any variety of texture one like can be produced on the boxwood block This cannot be said for either etching, mezzotint, steel, or copper, each having its ow methods, great as the masters have been wh have worked upon one or the other of thes materials; and as far as I have seen, the never have departed from the original mode o treatment, peculiar to the material they worked upon. Thus, they have necessarily missed the individuality of the painter they translated. The reason, of course, being that the material will not lend itself to variety of treatment.

Now, with regard to wood engraving on boxwood, any texture you like can be engraved upon this material, it is so adaptable. But it requires an artistic engraver, not a mechanic, to arrive at anything like good results. Happily, at the present time, we have plenty of right good artistic engravers, not only here in London, but all over the world.

The crowning advantage enjoyed by wood engraving, through which it obtains its immense superiority over all other methods, is that the engraver is enabled to work in both black and white line. This, in the hands of an artistic engraver, one who knows his work, and, beyond that, loves it, is a most valuable power.

Nothing is out of the range of imitation possible to wood engraving. The differences of textures of flesh, silk, satin, cloth, wool, steel, glass, the grain of wood, marble, weather-worn stone, furs and skins of animals, atmospheric effects, foliage of all kinds; all these it can represent, and beyond everything, it can render the differences between oil and water colour, and can accurately transcribe the old master's work with all its cracks and blemishes from damp and shrinkage. It has been said by some that the old masters cannot be rendered in this way except by photography.

As an example of this peculiarity of wood, I would call attention to an engraving after Fra Angelico, lately used to illustrate a paper on "Angelico at San Marco" by Mr. Grant Allen, in the "Pall Mall Magazine," a proof of which you will find upon the table. It represents the reception of Our Lord as a pilgrim by two Dominican monks in the garb of their order. The original is a somewhat damaged fresco, still occupying a lunette on the wall of the convent where it was first painted. I venture to think it will be seen on inspection that the engraving manages to reproduce the peculiar medium of fresco, the characteristics of the artist, the present state of his work, and the irregularities of the surface in a way that would be impossible with steel or copper, or any other medium. It, I think, completely answers the objection that wood engraving is incapable of giving the tone and manner of the old masters.

All things, I have said, are possible on wood; and this is secured by variation of line, admixture of dots, or round or lozenge-shaped spots or strokes of the graver, cut in different directions across one another. In fact, one can hardly lay down hard-and-fast rules with regard to the exact methods to be used. All depends upon the subject to be engraved and the feeling which it engenders. This, again, depends upon the thoroughly artistic sensibility and training of the engraver. He must first be an artist, in feeling at least, well grounded in his anatomy, daily using his pencil or brush in drawing or painting; in fact, an art student. This is most essential—that is to say, if he wishes to do good work. Then he must be well up in all the branches of art. He must take a pleasure in his work and turn out his best. Such an engraver will not feel inclined to do, what we will call "manufactured engravings," but rather will feel a fresh delight in every subject that comes before him. No matter who the master may be from whose work he may be engraving, each one is a new study or problem. He has to reflect how he can best render that particular painter's feeling and individuality.

In order to illustrate or rather bring thoroughly home to you what wonderful qualities wood engraving has, far-and-away beyond other reproductive arts, I will, with your kind permission, now draw your attention to the few subjects on view to-night, each one having been carefully chosen with that object. But for you to thoroughly appreciate the points that follow, I must ask you to kindly note the numbers of the examples that I shall speak of, so that after the paper is read you may go round and examine the subjects for yourselves.

Take, for the first example, "A Study of a Head" (No. 1), after the late Lord Leighton, P.R.A., compare that with the portrait of George Meredith, the author, after the painting by Mr. G. F. Watts, R.A. (No. 2). Here you have two painters with entirely different methods of handling; and I think you will find, on comparing the two proofs, that the individual touch and characteristic handling of each painter has been preserved in the reproduction. These two examples, one would think, would be quite enough to convince any one; but I will follow on with others, showing of what a variety of textures or changes in handling wood engraving is capable.

We have here on the table four engravings, after paintings by Mr. G. F. Watts, R.A., and if you place them side by side you will find the engraving has followed the changing, or gradual development of this painter's peculiar *technique*. On comparing (No. 3) the "Late Lord Tennyson," painted about forty years ago, with (No. 4) "Little Red Riding Hood," painted somewhat later, you will notice that the handling is slightly changed, moving towards what is shown in the next example of much later date (No. 5) "Love and Death." In this subject notice especially the drapery of the Angel of Death, in which you will see Mr. Watts' more marked *technique* of the present day. This quality, I venture to think, is still more fully shown in the engraving (No. 2) "Mr. George Meredith," painted only three years back. Here you have Mr. Watts in his very marked personality, as it is at the present time.

Then, further, as to what can be done on wood, take (No. 6) "The Recording Angel" also after Watts. This was engraved from a very highly finished chalk drawing, and, I believe, when you look at the proof from the wood block, the fact of the original medium will simply declare itself.

Next, I will call your attention to three engravings, after Mr. L. Alma Tadema, R.A., whose methods of painting are, as you all know, entirely distinct from those of the previous artists whose works I have just spoken of. The first engraving (No. 7) is from a water-colour drawing, entitled "The Old Story," and is exactly the same size as the original; and all here who are acquainted with Mr. Alma Tadema's work, know he is bound to thoroughly delineate textures, no matter in what medium he may be working. Being the genius that he is, he simply cannot help himself. So, how could any engraver go wrong with such a master of *technique* to translate. Anyhow, you can presently judge for yourself by comparing the difference of texture in the engraving of the drapery and marble in No. 7.

In "Cleopatra" (No. 8), I would call your attention to the hangings on the barge compared with other parts of the engraving. Then (No. 9) an engraving that was executed many years back, and being almost the first attempt at textures on wood, I thought would not be a bad example to bring before you, not that the engraving can be called good, but that the attempt at the textures was not so far bad, and that your attention should be drawn to the fact that flesh, glass, woollen fabric, wood, paper, and metal are here delineated. It is from a portrait of the late Professor Amendola. The professor is in the act of working upon a statuette of Mrs. Alma Tadema, wrought in silver, the drapery is oxidised, and the flesh pure silver. I think you will see that the texture of the different materials is kept in the engraving. There are two or three other and smaller examples from Mr. Alma Tadema's work on the table which are not in frames.

Here I think it will be appropriate to mention two of Mrs. Alma Tadema's most delicate and beautiful works, of which I have proofs on view to-night, and ask you to look at them not only as to the textures, but also to show how finished wood engraving can be; (No. 10) "Always Welcome;" (No. 11) "Well Employed." In both these examples, to thoroughly carry out the feeling of the originals you will see that every use has been made of the great variety of manipulation that the worker has command of in wood engraving.

We will now notice a few more examples (No. 12), "Portraits of Two Gentlemen," after Sir Joshua Reynolds, P.R.A.; (No. 13) "Miss Linley and her Brother," after the well-known picture by Thomas Gainsborough, R.A.; here you will see that a peculiar kind of texture has been brought into requisition to enhance the softness of the flesh lines; (No. 14) "Study of Old Woman," after Mr. James Sant, R.A.; (No. 15) "Study of Head," after Mr. Marcus Stone, R.A.; and (No. 16) "Graziella," after Mr. C. E. Perugini. The better to convey the handling of the last two artists, as simple a line as possible was made use of in both engravings. (No. 17) "The Return from the Fête Dieu," after the celebrated picture by Mr. Phil. R. Morris, A.R.A, shows what wood engraving can do from another style of handling in oil. (No. 18) "The Fairy Tale," after Mr. E. F. Brewtnall, R.W.S. In this several methods of manipulating the graver came in useful. (No. 19) "Fatima," after the same artist; in this, as in others, the texture of the curtain, which is slightly different from those previously mentioned, adds very much to the value of the materials of which the costume is composed. I would recommend your thorough examination of the proofs, as they will bring before you more vividly than words what a valuable agent wood engraving is as a reproductive art.

Now, as an example of the importance of the direction of line, I would instance the figures in the engraving (No. 20) after Sir E. Burne-Jones's "Wheel of Fortune." Notice here the way in which the line is made to curve upwards or downwards on the surface of the limbs, so as to give, not only the sense of relief or rotundity (the modelling of arm or thigh, or knee, or finger), but also the degree in which each part approaches to or recedes from the eye of the spectator. Many engravers often run their lines longitudinally, or in one direction only, over the head or limb, and rely upon varying thickness or closeness of line for the modelling or effects of light and shade. But, in my opinion, the best way, when possible, is for the engraver to make the lines follow and suggest the natural contour, bringing it delicately round at knee, elbow, or knuckle, so as to point out and accentuate the rotundity of the figure. It then accommodates itself both to the actual shape of the limb and to the nature of the perspective or foreshortening.

As specimens of wood engraving from water colour, I will take two portraits by Professor Herkomer, R.A., and am sorry I have no others to show you, but anyone can see for themselves in the best magazines and illustrated papers how beautifully wood engraving can render the transparent wash and crisp touch of this medium.

In the two specimens, "Professor Ruskin" (No. 21), and "Mr. J. W. North, A.R.A." (No. 22), the *technique* in the originals is peculiarly Professor Herkomer's own, so in these engravings you will see a slightly different kind of line has been made use of to render this medium, and more especially the handling of this artist.

Again, while on the question of line, look at the differences of touch used in the engraving of three portraits. "The Late Lord Tennyson" (No. 23), "The Right Hon. W. E. Gladstone" (No. 24), and "Mr. W. J. Linton" (No. 25), the father of American wood engravers, but an Englishman for all that, and one of the grandest of our English wood engravers. In the first case, what I will call a trembling, or shaky line, has been resorted to, to give age to the flesh; in the second a cross-hatched white line is used, so as not to detract from the principal black line which gives form; but the white line is so used by engraving it before the black line, and to a certain extent modelling the forms of the lighter parts, that it enhances the value of the markings of age in the flesh, without grinning, as it would if engraved at the end of the work which is so often done; and in the third, just a simple black line is made use of, which still gives the aged look, without rendering the markings too intense or conspicuous. In these three examples, observe how valuable is the use of both pure black and pure white line in rendering the hair. These three were engraved partly from photographs, and partly from a personal knowledge of the originals themselves.

Then further, as to what wood can do, we will take three engravings from pencil drawings. The first (No. 26), "A Study," is engraved from one of those beautifully finished drawings by Sir E. Burne-Jones; the second (No. 27) is also from the same hand, but the study was on brown paper, which gives a different texture to the drawing, so that in the engraving you will see that an entirely different method of treatment has been resorted to, to render this subtle difference. At the same time, it may interest you to know that this study was one of many for the picture of "King Cophetua and the Beggar Maid," and that Mr. Comyns Carr's son was the chosen model. The third (No. 28) is from a delicate drawing by Mr. E. F. Brewtnall, R.W.S., and in this, as in the others, I think you will find that the peculiar character of pencil work is retained in the engraving.

That these specimens somewhat demonstrate the wonderful versatility of wood engraving, is to me absolutely conclusive; while as regards the means employed in producing any of the blocks here introduced, engravers, or lovers of engraving, ought to see at a glance how they are done, and what advantages wood possesses over other methods.

But will all wood engravers take the trouble to arrive at these results? I sometimes doubt it. So many of them, I am afraid, think too much of the money to be got out of their work, and will not sacrifice the time or give the thought requisite to arrive at what they know to be their best. "That is good enough," is sometimes, if not often, the quiet cry with some. They, perhaps, have not sufficient feeling or love for their art, grand as it is. "Publishers," they say, "will not pay more than a certain price, so why should I sacrifice myself for their sakes?" Hence the stereotyped cry, "That's good enough; it will pass the art editor." But publishers will pay for good work when they want it; I only wish, for the good of wood engravers, they wanted it a little more often.

Something has latterly been said about the public not appreciating good art in the publications—that they are indifferent; and on that account we are also told that the publishers are not to blame in the matter of the bad art produced in a number of the current magazines and papers.

Perhaps. But, as the artist or engraver is powerless, if the publisher will not take of his best, we must look to the public for the encouragement so much required. What the public insist upon having, the publisher will be bound to give, if he wishes to prosper. In fact, you see the very best plates in some publications are either etchings, wood engravings, or photogravure. This is done simply to keep well with the public, which shows that they like a good thing when they can get it.

A very large section of the public, I am glad to hear, are crying out for better illustrations, and are longing for more knowledge of illustrative art. Many publishers see that want, and, with a few exceptions, they take undue advantage of it. They give anything that will pass for the week or month, and, I have no doubt, judge, from the rise or fall of their publications, whether to give better art or leave bad alone.

Now, let us take each of the reproductive fine arts in turn, look into their different methods of work, see the results, and compare these with what I have previously shown that wood can produce. How very far short they are in reproducing the *technique* of the painter! To begin with, I will take etching, as it is the first and highest of those methods, though not one of the true reproductive arts.

Mr. Robert Macbeth, A.R.A., has done some most wonderful plates from paintings by the late Mr. Fred. Walker, A.R.A., and others. Yet, with all his great talent as an etcher, he can only give the subject and the values. You do not find the *technique* of the painter; you see instead Mr. Macbeth's marvellous manipulation of the needle. I look upon etching as a painter's art to delineate the feeling of the artist himself in that particular medium; in fact, an original art. Decidedly, in my way of thinking, it never was, and never could have been, thought of as simply an imitative art. The more you look into it, the more you recognise that every line conveys the feeling of the painter-etcher, not of the copyist. And yet, at the present period, etching is being used regularly as a reproductive art, and the public think they cannot have anything much better than a proof-etching of any well known picture; they do not see that the etcher can only convey to the eye a very general idea of the original. That is to say, this art gives you the subject —the true values of the picture—but what i wanting is the individuality or *technique* of the painter.

In a good etching from a picture we have the etcher, not the painter. We have a beautifu art, and yet, if I may be allowed to say so, one which misses the actual art in this particula department. As to the question, who is answerable for this misapplication of an art that is so personally interwoven with the fibre of the creative artist and not the copyist. I leave others to answer.

Next, take mezzotint. This is a delicately beautiful art, but I think what I have said about etching will apply in some ways to thi also. It misses the one essential of a reproductive art—the power of preserving the individuality of the painter, We feel that wan intensely in looking at the result. His touch is not there. It is the mezzotinter's, and his alone, that we find in the engraving.

Then again, take steel and copper, I cite them together as they are pure and simple line and dot work. Everything depends upon the beauty of the line, the true translation of the subject in the outline and values. Beyond tha aim they fail utterly. As I said before the material on which they work does not lend itself to the handling or *technique* of the painter. To understand what I mean by this take a picture full of impasto and another very smooth and highly finished. Both will, when engraved on steel or copper, come out equal in value. The impasto has gone, but the finish remains.

With regard to photogravure, this process does give you somewhat the handling and touch of the artist; but for the very reason that its foundation is due to photography it does not come out quite true in its values.

I now approach the subject of the future of wood engraving and the likelihood of its permanence.

This I must say greatly depends upon the desire on the part of the public, or perhaps, I should say, to their gradually being led up to a stronger wish for a better class of illustration or reproduction than they get at the present time. In fact they ought now to get a far higher class of work given them considering the enormous profits made out of nearly every class of publication that is issued. But as it is they get cartloads of rubbish, and are as much as told that it is art and good enough for them.

I sometimes think that the British public must be greatly wanting in feeling for what is good in art, or otherwise they would not put with so much that is given them. Anyhow, e question here comes to the front. How ng will they go on putting up with this bad ork? when they could have better if they ould only strike for it, or insist strongly ough upon having it. If they would only do is, they would get the higher and more autiful work, for the publisher would be und to let them have their heart's desire. his would mean a higher class of work all und, and wood engraving would prosper ccordingly.

But this is not all that wood engraving is estined to accomplish. It will be in the ture, and not very distant future either, if orked by the engravers with their whole eart and strength, the leading reproductive ne art. I know there will be a big fight to go rough, but what matters, I feel we must win. I have only very faintly shown you what is ing done at the present, in methods of handng, and with other methods added by earnest udents, there is no end to what could be ne with the material. It must come to the ont. I do not say this idly, or without a owledge of what I see before me, as to its pabilities beyond other reproductive arts; t all depends upon the earnestness of the gravers, they must throw themselves heart d soul into their work, and be ready to ake almost any sacrifice for it.

Then what encouragement there is in the ct, that a strong taste for the beauty of the t is growing, and manifesting itself in the ger way in which artists' proofs are being ught, not only in this country, but in merica, France, and, I think, Germany also. This taste will naturally spread, it cannot lp doing so; and I ask all wood engravers work for this grand opening for the output their work. I would advise the purchase of pyrights of good pictures, selecting subjects at would be likely to take with the public. ngrave and publish them in the same way at all other reproductive plates are published, at is to say, a limited number of artists' oofs with prints after letters at half the ice to follow.

This would place upon the market a good d comparatively cheap art for the general blic to indulge in; as the wood engraver uld sell his artists' proofs at a lower rate an that at which the other fine art plates e published, simply because the printing ould cost him less; and I feel confident at the public would largely respond.

If the engraver could not see his way to purchase the copyright, I would suggest a partnership between the artist and engraver. The engraver to put his work against the value of the artists' copyright, each to contribute an equal share towards the outlay for printing, paper, and other expenses necessary to the publication of a plate, and divide the profits. This would work to the benefit of both.

The wood engraver in this way would free himself to some extent, and show what could be done, independently of magazines or papers. Not that he would necessarily cut himself adrift from these sources of work, but would be helping himself onward to a higher line, in which he would not be so much ground down to help to build up the fortunes of others, as is too often the case at the present time; but thank goodness all publishers are not alike in that respect.

It has been said, and with truth, that the individual workers must die out—very true, and that fresh blood will be wanted to take the place of those defunct members of the art. I believe one way to accomplish this would be through the action of the Royal Academy of Arts, who are our pioneers in most of the fine arts. They should recognise wood engraving as a fine art, as well as steel and copper. They should elect members of this art as associates, as well as open their schools to students of the same, under the same rules as those which apply to students of painting, sculpture, and architecture, whose ultimate career might be that of the wood engraver. These students would then be able to have the good training both in drawing and painting, which knowledge is most essential to anyone wishing to be thoroughly able to reproduce engravings from the paintings of others. For the eye must be trained in feeling and colour, as well as in drawing, if the engraver is to render with any approach to truth the relative values of any painting he may have to reproduce.

One sometimes wonders what becomes of all the Royal Academy students, of whom a very small proportion, in the end, come to the front. What happens to the remainder, who intended at least to try and make a great name? Perhaps it was that they were wanting in creative power. Then if not painters, sculptors, or architects, they would, perhaps, make first-rate engravers. And why? Simply because of the splendid training they would have gone through in the antique, life, and painting schools.

Just think once more, if they only had had the chance of studying one or other of the reproductive arts at the same time that they were studying to be painters or sculptors, what a splendid band of workers in the reproductive arts we should have to go on with in the future. The cry of decay in this or that special art would not be heard; it would fade away to be repeated no more. These arts would revive in every way, and there would be a splendid future for them all.

I feel most strongly on this point, that it is to the members of the Royal Academy of Arts we must look to for some of the help that is required to prolong the life of this beautiful art. It ought not to be left to the dogged determination of this or that individual, to force his art to the front without aid or encouragement.

These reforms would, I feel sure, open up one way to give the impetus to wood engraving that it now so much requires. The art would be more widely recognised as a fine art; a more general market would be opened up for the collections of fine art wood engraving plates; and the public would be enabled to get good art at a price they could readily afford.

It is principally to this fine art outlet that I look forward to as the great and future field for wood engraving.

DISCUSSION.

The CHAIRMAN said he was not in any way specially qualified to speak on this subject; but some years ago he had some part in attempting to establish a school of wood engraving in Kennington, with his friend, Mr. John Sparkes, and for some time it went on very well indeed. Mr. Sparkes used to come to him with doleful tales, saying that process work, and photography, and photogravure, were disheartening the pupils, and the school was dwindling away. He was, therefore, very glad to hear the prophecies uttered in this paper, which promised much better days for the art of wood engraving. He had very great sympathy with the aspirations of the paper, for it was essentially a fine art, inasmuch as the kind of wood engraving described was a medium for expressing the artistic feeling of the engraver. Mr. Biscombe Gardner had had a great deal to do with the revival of wood engraving as a true interpreter of great artists, especially perhaps in reproducing the works of that great artist, Mr. Watts. He concluded by asking the meeting, before carefully inspecting the beautiful specimens exhibited, to join in according a hearty vote of thanks to Mr. Biscombe Gardner.

Mr. HUGH STANNUS said he knew Mr. Bisco
Gardner's work well, and had made a small collec
of it, as being the work of one who might be sai
present to be the leader in the grand art of Eng
wood engraving. He was glad to possess p
copies of some of his beautiful works,
cherished them highly. Reference had been m
to the capabilities of the art, and the resou
which were open to the wood engraver—w
lines, black lines; white dots, black dots, and cr
hatchings in either white or black (though easie
white than in black)—and the wonderful judgm
which Mr. Gardner had shown in using just
right method of interpretation in each case, pla
him in the rank of one of the great artists of the d
He was sorry to have to say this in his presence,
it was only what he had said before, and had ac
upon his convictions. On looking at the portrait
Tennyson one could see in it a variety of *techni*
which was perfectly marvellous, and which fully b
out everything which had been stated in the pa
In fact, a perfect lecture on the art of wood engrav
might be given with that portrait only as the t
and illustration. Of all photographic proces
photogravure was the only one capable of giv
texture; and as so much of the essence and beaut
a painting lay in the kind of brush work which
artist put into it, the amount of colour with wh
he charged his brush, whether it was dry painti
or full painting, and further, the direction of
brush-strokes, so much of the individual characte
the painter was displayed in this way that one ou
to be very thankful to anyone who could reprod
it. So far as his observation and judgment w
that could only be done by two processes, pho
gravure and wood engraving. He had some perf
reproductions in the photogravures in his book
Alfred Stevens, which had been executed by t
Autotype Company in their atelier at Ealing; b
where the brush-strokes were strongly marked by t
painter, then wood engraving could show the dir
tion by the lines, either white or black, more clea
than photogravure. Mr. Gardner had spoken of t
direction of the line, and that was of the high
importance in all line work. A vertical surface mig
be represented by vertical lines, a level surface
horizontal lines, and a slanting surface by slanti
lines, and a modelled surface by lines following t
round of modelling. The curve of a man's a
might be indicated by the curve of the line, a
the subcutaneous veins would be shown by
little cockling up, giving a sort of *section of t*
modelling of the arm, so that a modeller mig
take one of these wood engravings and mod
from it; and he could not conceive of any high
praise than that statement. Stress had be
laid upon the fact that photographic process
were not capable of giving values; there mig
be a picture in which there was yellow drapery
one portion and full blue in another; in th
picture the yellow would be much lighter tha

e blue, but in the photograph it would · darker. There had been, or were to be, some pers dealing with this question, and it would be rhaps discounting them, to some extent, to go into now, but he thought it would be admitted that iotography was now able to give values much ore accurately than was formerly the case. The ggestion at the close of the paper: that the Royal cademy, which was the centre to which all art in ngland converged, should give more recognition to e art of wood engraving, was very pregnant, and, hoped, would bear fruit; and when in future ars they found wood engraving revived in the tistic manner pleaded for by Mr. Gardner, and lly and fairly recognised by the Academy, they ould look back to this paper, and feel grateful to m for having brought it forward.

The CHAIRMAN, in putting the vote of thanks, hich was carried unanimously, said he hoped Mr. iscombe Gardner might be the first representative wood engraving at the Royal Academy.

Mr. BISCOMBE GARDNER briefly responded, and ie meeting adjourned.

Miscellaneous.

PATENTS OF 1895.

The thirteenth report of the Comptroller-General Patents, Designs, and Trade Marks for the year 395 has just been published. The number of appli- tions for patents during the year was 25,065, this ing a diminution of 321 on the number of applica- ons for last year. This is so far remarkable, as it is actically the first year since the Patent Act of 1883 which the number of applications has not shown increase. In 1884, the first year under the new gulations, there was a larger number (17,110) ian in 1885 (16,101), but this is accounted for by ie fact that a great number were held back in order iat the applicants might take advantage of the duced fees introduced by the Act. From 1885 to 894 the increase was continuous. The highest umber under the previous law was 6,241 in 1882. is mentioned in one of the appendixes that ie total number of patents for inventions granted etween 1617 and 1852, in which year what may be rmed the first Patent Reform Act was passed, was 3,561, just about half the number now applied for a single year. The report points out that the ecrease of last year was only in applications accom- anied by provisional specifications. From this it iay be concluded that applicants find that the iethod of proceeding by provisional specification is ss really advantageous than that of filing a complete pecification at once.

The total receipts for the year amount to the large sum of £187,012; the expenditure amounts to £100,671, leaving a surplus of £86,341. It should be mentioned that over £10,000 of the expenditure was in connection with the new buildings of the office.

The number of designs registered, like the number of patent applications, is rather less than last year. There were 20,507 single designs and 910 sets of designs. A few more trade marks were registered, the number of applications being 8,272, as compared with 8,013 last year.

The report also contains a good deal of curious statistical information as to the number of patent applications from various countries, the numbers and per-centages of patents kept in force by payment of renewal fees, and other statistics relating to the general work of the office.

GUATEMALA EXHIBITION, 1897.

Information has been received from the Foreign Office through the Science and Art Department respecting a Central American Exhibition, to be held at the Capital of the Republic of Guatemala, from the 15th March to the 15th July, 1897. All goods intended for exhibition will be allowed to enter duty free, but in the Foreign Section, all goods, when disposed of, will have to pay the duty thereon, and carry out the fiscal regulations of the country, except in cases where the article or articles sold have taken a prize, in which case they will be exempted altogether.

With reference to the Exhibition, the Consul-General at Guatemala reported to the Marquis of Salisbury, "That at the present time the quantity of British goods finding their way to Central America compares favourably with other countries, except the United States, still, it appears to me that this Exhibition might be made a means of yet further introducing British industries, if our mercantile community will take it up. It would be necessary for the exhibitors to have some gentleman of good standing, well acquainted with commerce and the requirements of the country, to represent the English Section, receive orders, and act as an intermediary between the exhibitors and the purchasing public, so as to build up a permanent increase in the use of English goods. At the present time there is a great demand for machinery (for railway contractors, coffee plantations, sugar plantations, &c.) and hardware of every description; improved appliances for dairy purposes, electric light, and motive power, plant, bicycles, &c., all clothing materials, musical instruments, cutlery, jewellery, foodstuffs, fancy goods, and 'articles de luxe,' generally.

"The Government are earnestly desirous for foreign nations to take part in the Exhibition; at the same time, it must be remembered that it was decreed by the National Assembly that this should be a Central

American Exhibition, and that in its general principles this must be adhered to; but there will be a department assigned to foreign nations, enjoying all the privileges possible, and the right of competing for the prizes."

The exhibits will be:—(1) Science and letters; (2) education; (3) fine arts; (4) mechanics and construction; (5) agriculture, horticulture, arboriculture—special cultivations; (6) fauna and flora; (7) ornamentation; (8) various industries; (9) natural products; (10) transport; (11) mining; (12) immigration.

All applications for space must be addressed to the Central Committee before the 31st August, 1896.

RUSSIAN EGGS.

Mr. James V. R. Swann has printed a paper containing a large amount of valuable statistics respecting the importation of Russian eggs into Great Britain, from which the following particulars are taken:—

During 1895, the United Kingdom imported from 20 foreign countries and British possessions 1,526,000,000 eggs (80,551 tons), valued at £4,003,440, or an import exceeding 4,000,000 eggs (209 tons), valued at £10,941 (almost £11,000) daily.

Forty per cent. of the eggs consumed in the United Kingdom come from abroad, and fully 90 per cent. of the eggs handled in the towns of England and Germany are of foreign origin. During 1894 the consumption of imported eggs per head of population in the German Empire was 30, and in the United Kingdom 37, and this consumption of imported eggs per head of population in the United Kingdom has risen from 4 in 1853 to 39 in 1895. In those countries that have a surplus egg production, the consumption of eggs per head of population approaches that of the United Kingdom, and in most egg-exporting countries the number of eggs exported is less than the number retained for home consumption.

During 1895, 31 per cent. of the imported eggs received in the United Kingdom came from within a radius of 650 miles, 45 per cent. within a radius of 1,200 miles, and 24 per cent. exceeded 2,000 miles. From official quotations published in *The Grocer*, may be learnt that imported eggs are from 35 to 60 per cent. cheaper in summer than in winter, depreciate in quality from 25 to 45 per cent. in transit, and lose on an average from 17 to 50 per cent. in value before they can be marketed.

The United Kingdom and the German Empire depend largely upon Austro-Hungary and Russia for their supply of imported eggs. The exact quantity taken by the United Kingdom cannot be given, as all eggs coming from German ports figure in the Board of Trade returns as German produce. Even Italian eggs are classed with eggs coming from France; while Belgium, a country that does not produce sufficient eggs for its own needs, is re sented in the Board of Trade returns for 189 having furnished the United Kingdom with 6 cent. more eggs than came from Russia.

During 1870 Russia exported 11,000,000 (575 tons), valued at £10,932; 1880, 77,000,000 (4,077 tons), valued at £93,371; 1885, 235,000 eggs (12,369 tons), valued at £343,373; 1 755,000,000 eggs (39,736 tons), valued at £1,236,1 and in 1895, about 1,250,000,000 eggs (65,784 to valued at £2,046,250. These amounts do not incl the white and yolks of eggs exported from Rus exceeding 1,100 tons annually. The countries which these eggs are exported are Austro-Hung Belgium, England, France, Germany, and Hollar

During the first nine months of 1895 (Januar September), 1,135,000,000 of Russian eggs w exported. Thirty-five per cent. (369,000,000) w shipped from the ports of St. Petersburg (77,000,0 Riga (244,000,000), and Libau (174,000,000). teen per cent. (185,000,000) entered Prussia by and 49 per cent. (534,000,000) passed by road rail into Austria, through Galicia and Hungary.

A large proportion of these eggs were gathe 600 to 1,600 miles from the Russian frontier inland stations, and sent forward by water and r The railway facilities in Russia are satisfactory, things considered, and it is just possible for la exporters to receive their goods from the most dist stations within eight days. The railway wagg carry from 100 to 150 cases (144,000 to 152,100 eg equal to 7¾ to 8¾ tons). The total export of Russ eggs during 1895 (1,250,000,000) is represented 8,500 to 8,500 full waggon loads.

All Russian eggs when they cross the Aust Hungarian frontier lose their nationality. All eg collected in Poland and consigned to agents Galicia, &c., are sold as Austro-Hungarian.

The greater proportion of Russian eggs that rea England from German ports are branded Austri produce (and this branding takes place after lar ing), though it is well known that the eggs are r of Austrian origin. During 1888, 678,000,000 Russian eggs (35,684 tons) were exported, and b one-tenth (66,000,000—3,474 tons) figured in t official returns of Europe as Russian produce. T remaining nine-tenths (642,000,000—32,210 tor were sold as other than Russian produce.

The regular line of steamers from Russian po (Baltic) carry millions of Russian eggs during t season to Antwerp, Copenhagen, Hamburg, &c these eggs are consigned to the United Kingdo &c., as Belgian, Danish, and Austrian produce.

In the central and south-west governments Russia, and the provinces of Poland that bord Austro-Hungary, entire communities rely upon poult and poultry produce for their livelihood; but the ma supply of poultry produce for the needs of th Empire come from 30 departments in Russia an Poland. The supply of eggs for the export trade gathered at innumerable sub-agencies in connectio th 153 district agencies in Russia, and 22 in land; and 86 inland packing stations in Russia d 19 in Poland practically monopolise the supply eggs at the disposal of the trade. The eggs are cked in the interior, and consigned to 4 exporting ntres in Russia and 12 in Poland. At the ex- rting centres, the leading exporters have their adquarters, with extensive premises for their busi- ss. All eggs are re-examined, and, if neces- ry, repacked in fresh straw before leaving the untry. During the season this industry gives nployment to 7,500 to 8,000 peasants in the terior of Russia and Poland.

The leading firms in the egg trade, as in all other ades, have first choice of all produce brought into e market. As a rule the leading exporters com- ne, are a compact body, and by pooling their in- rests practically regulate prices, &c.

In the interior of Russia, on the outskirts of the gg-producing regions, peasant hawkers travel the untry in carts and barter their wares. Egglers of is class travel routes with persistent regularity, d their days of calling are known and expected. illions of eggs are thus gathered from remote dis- icts by littles and lazily, and when one or more ads are collected they are carted to dealers, mostly ws, or the nearest market and sold.

Eggs carted loose and carried long distances get irty, cracked, broken, and soiled; and the jolting ey receive impair their keeping qualities. The reater number of Russian eggs are gathered over a st tract of country, and this neceesarily involves nsiderable delay between the day of laying and the e day of packing. A great proportion of the ggs are a week old when gathered by the collectors, nd take several days to come from the place of ying to where they are stored, and unless the ore is near an agency, there is another delay ere he eggs get examined and packed. However, few ggs are refused by coster-men, for eggs that won't ell in the country find a ready market in the capital.

Under more favourable conditions, local eggs are athered by collectors, &c., and sold to store- eepers, or peasants exchange their eggs for pro- uce at a local stores. When the storekeeper has athered one or more loads the eggs are carted to ub-agencies, or the nearest market where agents eet, and bargained for. Each egg is then xamined, sorted, &c., and paid for—per 1,000 ount—at the price bargained, the dirty, soiled, racked, and ruptured eggs being accepted at liquid rice, or consigned to albumen factories.

All eggs exported from Russia pass through several ands before they reach the packing station. Before acking the eggs are sorted, and only the best and rgest exported (speculators excepted). As a rule, ggs intended for export are packed in the interior f Russia in dried straw (in a similar manner to ontinental eggs), in cases containing 1,440. The ases having a double partition in the centre, so hat they may easily be sawn in two, representing 720 in either half case. The eggs are inspected by an expert sorter and packer. An experienced Russian can handle 200 gross of eggs, and pack them (28,000) in straw, in cases (20), in a working day.

There is a certain amount of speculation in eggs at certain seasons, and consignments of eggs from some districts in Russia have to be cleared within a short time to prevent a severe loss. Eggs are often in the hands of collectors in Russia for some considerable time, just the same as they are in the hands of exporters. In the interior of Russia, at the egg centres, from 10 to 15 per cent. of old and dried (stale) eggs are found in every lot brought to the notice of exporters. The *minimum* waste in eggs (*extras*) sent from inland packing stations and re-examined at the frontier depôts is 4 per cent. bad, with 5 to 10 per cent. dried eggs, invariably sent forward. The usual expectation of the trade with Russian eggs re-packed at frontier depôts is 5 per cent. bad, and 20 per cent. evaporated.

With first-class produce (*extras*) the *minimum* waste from inland packing station to port of importation is 5 per cent. bad, and 10 per cent. evaporated. With other than first-class produce (*selected*) the *minimum* is 10 per cent. waste, and 20 per cent. evaporated, and with *ordinaries* and speculative eggs from 25 per cent. waste, and 30 per cent. evaporated, to total loss ere the eggs reach the consumer.

The proportion of eggs exported from the northern ports of Russia, weights and quality considered, are:—Extras, 20 per cent.; selected, 35 per cent.; ordinaries, &c., 45 per cent.

Notes on Books.

INVENTIONS AND THEIR COMMERCIAL DEVELOPMENT. By John Samson. London: "South American Journal" office. 1896.

One of the greatest difficulties in the way of inventors is that of introducing their inventions to the world and securing sufficient capital for its development. As a rule this is not a point which is often dealt with in the abundant literature which has grown up about inventions and patents, but Mr. Samson has perceived the want and in the little book under review he has made some attempt to supply it. How many useful inventions have been crushed by want of capital for their development it would be impossible to say. Perhaps not a very great many, though probably many inventors have suffered serious loss, and have seen others reap the benefits of their original work, owing to their not being in a position to spend the necessary money on the advertisement and development of their invention.

Mr. Samson, after some sensible remarks about inventions and patents generally, goes on to discuss the various methods available for the purpose of bringing out patented articles commercially, and gives a full description of the proceedings generally adopted in bringing out a company for the exploitation of an invention. He winds up by suggesting the formation of a "Co-operative Patents Development Company." It is thought that such a company might deal generally with inventions submitted to it, advise inventors, and, when necessary, assist in the promotion of subordinate companies for the working of individual inventions. Whether such a scheme would work it is not very easy to say. As a matter of fact it would seem most probable that really valuable inventions, as now, find a separate market, while a company of this sort would be swamped by enthusiastic and needy inventors, each convinced that his design would regenerate the world, and each utterly blind to the demerits of his discovery.

It must also be remembered that it is often impossible to say what the value of a new invention may be until it has been tried. Many promising inventions are of no value whatever in practice, while others, which may be of a very unpromising nature at first, may prove a source of considerable wealth to their inventors.

MODERN OPERA HOUSES AND THEATRES. Examples selected from playhouses recently erected in Europe, with descriptive text, a Treatise on Theatre Planning and Construction, and Supplements on Stage Machinery, Theatre Fires, and Protective Legislation. By Edwin O. Sachs and Ernest A. E. Woodrow. London: B. T. Batsford. Folio. Vol. I.

This elaborate work, to be completed in three volumes, will be illustrated by a series of 220 plates, besides about 500 diagrams included in the text. It is intended as a continuation of the atlas on the theatres of an earlier period published by M. Constant, at Paris, in 1882, but Mr. Sachs has endeavoured to combine the advantages of an atlas with those of a text-book. The present volume contains examples from Austria-Hungary, Germany, Great Britain, Holland, and Belgium, Norway and Sweden, and Russia.

The second volume will contain an equal number of illustrations of theatres in France, Italy, Switzerland, and Spain, as well as further examples from Austria, Germany, and Great Britain, and the third volume will contain a complete treatise on theatre planning.

The author divides theatres into five classes:—(1) Court Theatres; (2) National and Government Theatres; (3) Municipal Theatres; (4) Subscription Theatres; (5) Private Theatres. Of these the first four classes are essentially Continental institutions. Mr. Sachs points out that "No more striking demonstration can be afforded of the differences in requirements of theatre-building than a comparison of Continental ideas on the subject with those prevalent in England. In this country, with but few exceptions the private theatre is governed in its requ e- ments by investors or ambitious actors, who cater or the pleasure of sensation-seekers among a pe e practically devoid of any feeling for architecture. n the Continent it is far otherwise; there a gen e interest is manifested in architectural work, with e result that popular and invigorating drama fin a worthy home amid appropriate and dignified -roundings, and even the variety entertainmen s housed in a building of considerable architect l pretensions."

It will be remembered by members that Mr. Sa s read a paper before the Society on December 5, 1 , on "Fire Protection" (*Journal*, vol. xliii. p. 4), and that Mr. Woodrow communicated an essay n 1884, on "Arrangements for the Prevention d Extinction of Fires in Theatres" (vol. xxxii. p. 5 , and another in 1892, on the same subject (vol. . p. 785).

MEETINGS FOR THE ENSUING WEE

MONDAY, JUNE 8—British Architects, 9, Conduit-street, 8 p.m.

TUESDAY, JUNE 9...Medical and Chirurgical, 20, Hano -square, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m.
Photographic, 12, Hanover-square, W., 8 p 1. Messrs. Cross and Bevan, "Cellulose and Derivatives." 2. Captain W. de W. Abn "Printing Densities."
Anthropological, 3, Hanover-square, W., 8½ p 1. Mr. H. W. Seton Karr will exhibit Fl Implements from the Egyptian Desert, and Collection of Photographs taken in Somali-la 2. General Robley will exhibit a Collection Tattooed Heads from New Zealand. 3. Mr. S. Myers, "An Account of some Skulls Discover at Brandon, Suffolk." 4. Dr. R. M. Connol "Social Life in Fanti-land."
Colonial Institute, Whitehall-rooms, Whiteha place, S.W., 8 p.m. Mr. Sandford Flemi "Canada."
Gas Institute (at the HOUSE OF THE SOCIETY ARTS), 11 a.m. Annual General Meeting. Reading of papers and discussion.

WEDNESDAY, JUNE 10...Geological, Burlington-house, W 8 p.m.
United Service Institute, Whitehall, S.W., 3½ p. Major-General J. M. Moody, "The Employme of Retired Soldiers, Sailors, and Marines."
Gas Institute (at the HOUSE OF THE SOCIETY ARTS), 11 a.m. Annual General Meeti (continued).

THURSDAY, JUNE 11...Royal, Burlington-house, 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.
Gas Institute (at the HOUSE OF THE SOCIETY ARTS), 11 a.m. Annual General Meetir (continued).

FRIDAY, JUNE 12...Astronomical, Burlington-house, W., p.m.
Physical, Chemical Society's Rooms, Burlingtor house, W., 5 p.m.

SATURDAY, JUNE 13—Botanic, Inner Circle, Regent's-parl N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 2,273. Vol. XLIV.

FRIDAY, JUNE 12, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty Second Annual General Meeting for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, 24th June, at 4 p.m.

(By order of the Council),
Henry Trueman Wood,
Secretary.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening, 17th June.

The reception will be held by Major-General Sir John Donnelly, K.C.B., Chairman, and the Members of the Council of the Society from 9 to 10 p.m.

Promenade Concerts will be given by the Band of the Royal Artillery in the North Court, and by the Red Band in the Textiles Court. A Vocal and Instrumental Concert will be given in the Raffaelle Gallery.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual Refreshment Buffets in the Central Corridor of the Museum.

Each Member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be given in the programmes which will be distributed on the evening.

The cards of invitation have been issued to members.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors should send in descriptions of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

INDIAN SECTION.

Thursday Afternoon, May 14, 1896; Sir Richard Temple, Bart., G.C.S.I., C.I.E., in the chair.

The Chairman:—I need not say much by way of introduction of Mr. Christison, but if you could realise by your mental vision as I can by mine the lovely places from which he hails, the picturesque locality in which his industry has been conducted, you will feel your interest redoubled in what he has got to say. When I look at him I recall the memories of the glorious views, the mighty peaks piercing the sky, and the snowy summits and the picturesque spur on which the Tukvar plantation was situated right over one of the affluents of the river, the glorious panorama with which it is surrounded, the magnificence of the vegetable kingdom, the trees, ferns, and flowering shrubs; if you think of these, you will lend an interested ear to the paper. Mr. Christison has just reminded me of things which, in the lapse of years, I had almost forgotten. When I, as Governor there, had the honour of entertaining the Darjeeling volunteers, an excellent corps consisting of stalwart tea planters, he (Mr. Christison) sat on my right hand, though he was not then an officer. These memories bring back the time to me when the tea planters were a power in the hill country; they were the pioneers of British influence and Western civilisation in regions that were adjacent to Thibet and the Chinese Empire.

The paper read was—

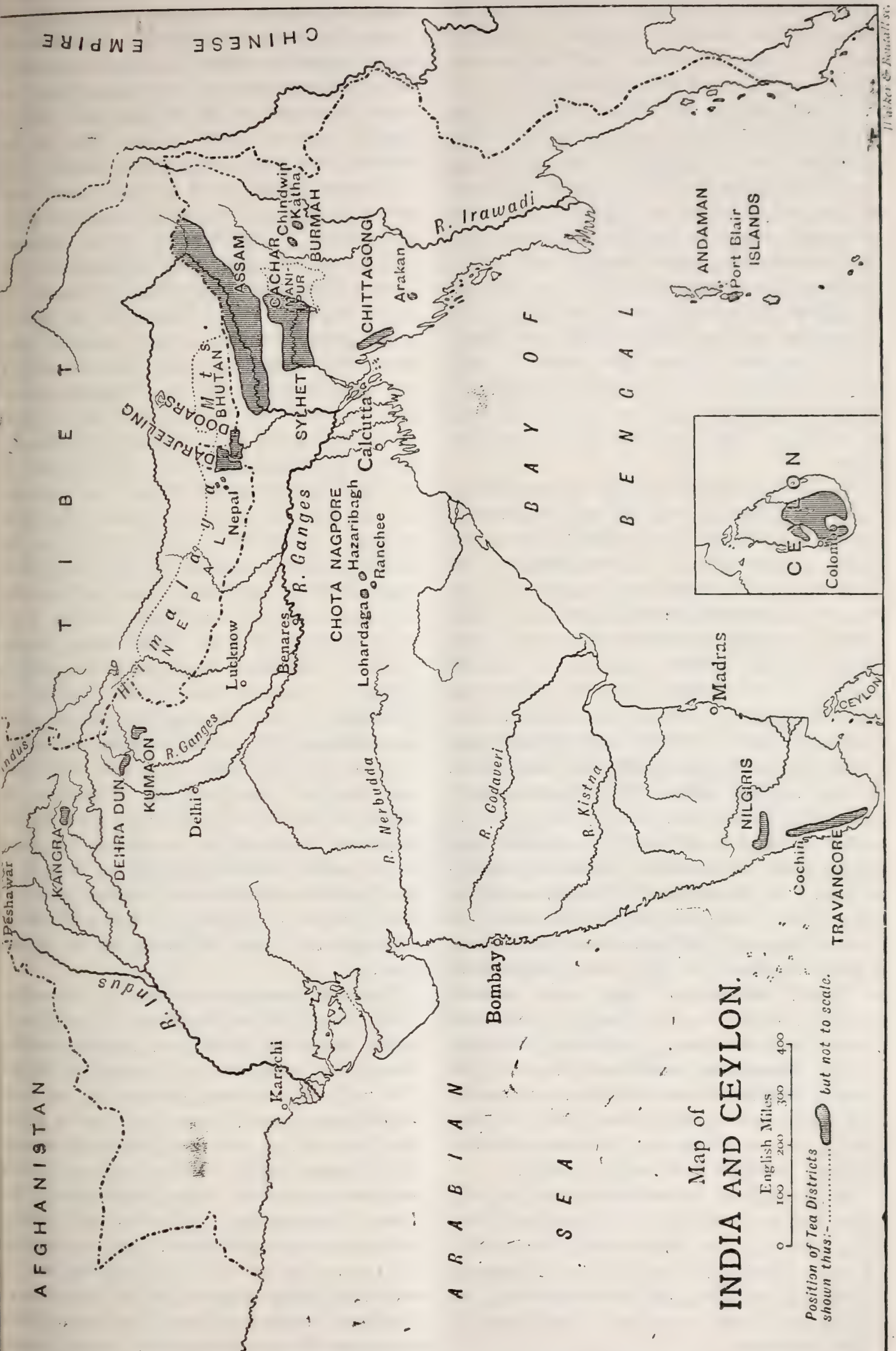
TEA PLANTING IN DARJEELING.

By Geo. W. Christison.

My first duty—which is a pleasing one—is to thank the committee of the Indian Section of the Society of Arts for having done me the honour of inviting me to read a practical paper on tea. As the history, progress, commercial aspects, and complete statistics of the industry have been exhaustively dealt with before this Society by others, I shall best employ the time allotted to me this afternoon by giving a brief outline of the culture and manufacture of tea in Darjeeling, with some suggestions on a few points of vital importance, referring to that district in particular and the industry generally, drawn from my own observation and experience.

The annexation of Darjeeling (strictly British Sikkim, and British Bhutan, exclusive of the Dooars) is but a comparatively recent chapter in the history of the extension of British rule in the East. Until 1815, when the country was brought into notice by the Goorkhas invading the territory of the Raja of Sikkim, that district was practically a *terra incognita*. This led the East India Company in 1816, at the close of our war with Nepal, to espouse the cause of the Raja and enter into a friendly treaty which constituted Sikkim an independent state under British protection. In 1835, 138 miles of Sikkim were ceded to the East India Company for a sanitarium for Bengal, in lieu of which an annual allowance of £300 was granted. In 1850, after the Sikkim war, some more hill territory and also the Terai were added, the subsidy, however, at the same time being enhanced very materially. And in 1865 the hill district of Daling was annexed from Bhutan as the outcome of the expedition of 1864, and the war with that state just then terminated.

The district is mainly situated on the lowe and outer ranges of the Himalayan mountains but as stated, includes the Terai which is an unhealthy level sub-montane tract of forest, o what was up till 30 years ago almost uninterrupted forest. It is bounded on the east by Bhutan, west by Nepal, north by independent Sikkim with Tibet beyond, and on the south-east and south by the Dooars tea district and Purneah in Bihar, and extends from about 26° 30′ to 27° 13′ N. latitude Though in area it hardly exceeds that o a second-rate English county, it ranges in elevation from about 350 feet to altitudes o over 12,000 feet above sea-level. The town, or, as it is called, the "station" of Darjeeling, which is the administrative head-quarters of the district, as well as the health resort for the Government and residents of Bengal is charmingly situated on a ridge at an elevation of 7,167 feet, commanding a magnificent view of the snowy range (about 40 miles distant and rising to over 28,000 feet), and to the north of Calcutta 379 miles by rail, but somewhat less in a direct line. Any attempt to describe the magnificent and sublime scenery is, fortunately, outside my province, as it is altogether beyond my powers. It is impossible for me in words to convey even any adequate idea of the steepness and irregular configuration of this mountain territory to those who have not visited it, though this feature must not be lost sight of in our consideration of the main subject of this paper. The mountains do not rise by any series of inclined planes or uniform undulations to their summits. The main trend of the ranges is towards the "snows" —generally from south to north—and of the torrents and rivers in the opposite direction from the snows towards the plains, but there are also side branches of importance running east and west (one of those, the Little Rungheet river, actually flowing north-east, and the adjacent mountain ranges ascending south-west), and many minor spurs and streams are in the very opposite direction to the main ones. On this account, the interior of the hill district generally presents a somewhat confused labyrinth of ridges and valleys. A considerable proportion of the hill area is so precipitous as to grow nothing but scrub or an occasional tree in the crevices of the rocks, and much is unfit for tea or cultivation of any description; but the soil on the gentler and some of even the extremely steep slopes is good and of surprising depth, considering the situation. As a rule, the best soil on the hills is



Map of
INDIA AND CEYLON.

Position of Tea Districts shown thus:........ but not to scale.

Walker & Boutall sc.

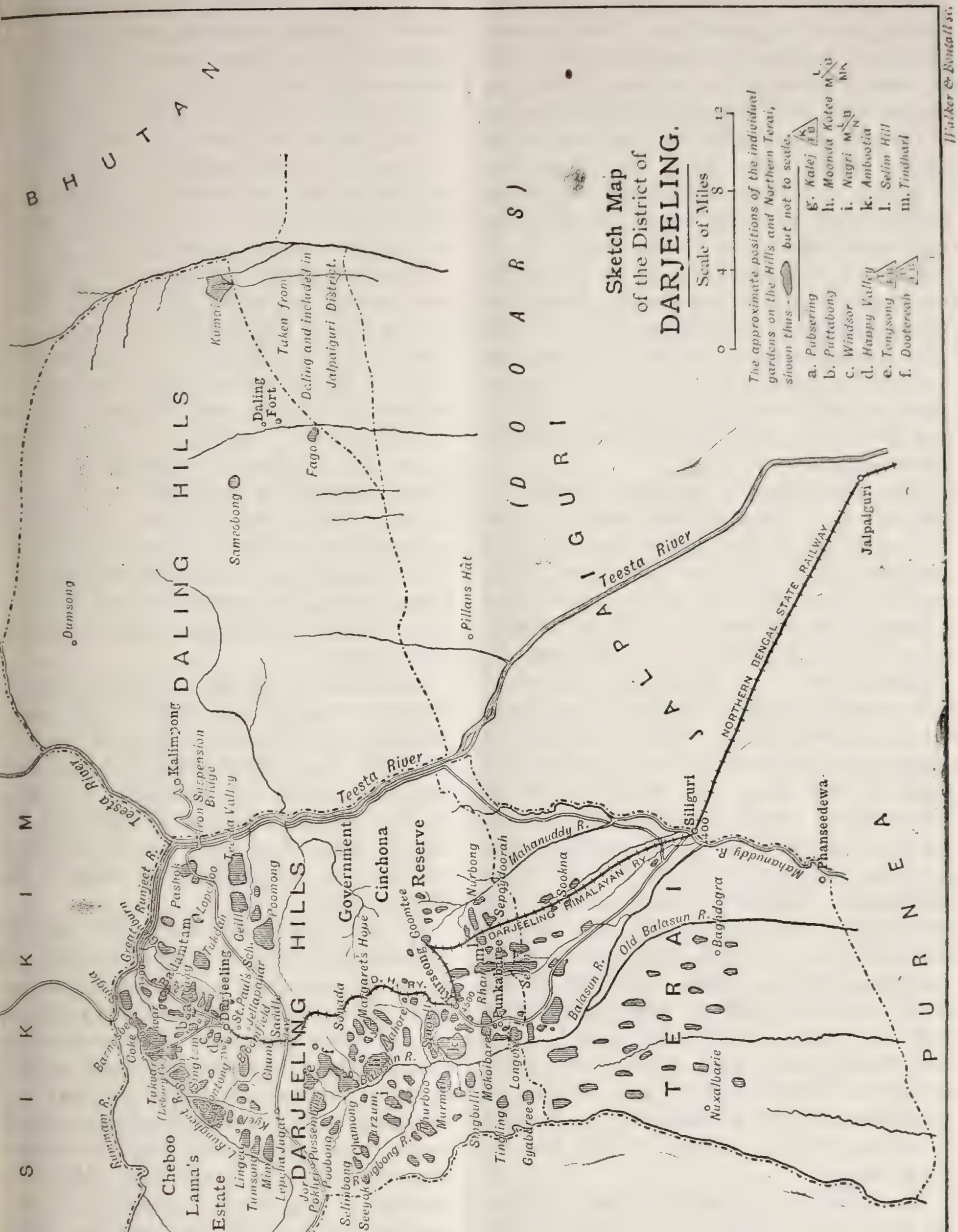
found from 2,500 to 5,000 feet; that below 3,000 feet is generally dry, and the tea thereon more subject to blights. Elevations over 5,500 feet are rather cold for tea—certainly for its rapid growth—though it is to be found thriving and doing fairly well from 6,000 to even 7,000 feet. Owing to the extreme steepness and irregularity of the ground, the roads have to be laid off in zigzags of greater or less length, when, as is the rule, an ascent or descent has to be made, or in sharp curves where contouring more levelly round ridges and into the indentations. This renders the length of roads from place to place out of all proportion to — not unfrequently over twice, and occasionally almost three times as great as—the distance as the crow flies. The district government roads are, as a rule, at gradients of 1 in 9 to 1 in 7, and are from 10 to 7 feet wide.

As stated, owing to the zig-zag and winding nature of the roads, and the wide intervening spaces of forest and jungle, the length of the roads is very great, in proportion to the cultivable and rateable area, especially as the Forest Department does not pay road or public works' cess, and the vast tracts of native cultivation nothing directly and next to nothing indirectly. In my time, the local railway was also exempted. For these reasons, as well as on account of the district being a frontier one, containing a military station and sanitarium, it has special claims for "grants-in-aid" towards its roads and bridges, in regard to which, it must be admitted, Government has, on the whole, been liberal, sometimes especially so. Yet I hold that, in justice, as well as viewed as a fair and legitimate matter of account between the Government departments, a great landlord like the Forest Department of India, claiming a large clear revenue annually, ought to be charged both land revenue and road cess. Incalculably valuable as this department undoubtedly is to India, profit should not be its chief aim; and such a step would cause the department all the more adequately to realise its immense responsibilities in holding such vast territories.

But, in addition to locomotion and soil, this rapid and great variation in elevation affects the climate, health, and working capabilities of the inhabitants, native and European, vegetation, humidity, and, to some extent, the quality of the tea, to which allusion may be made hereafter.

The rainfall varies greatly throughout the district. At the "station" the average is about 120 inches, and on the tea-gardens (lower elevations) it ranges from 75 to 1 inches and even over annually. The defect f tea in regard to rainfall is that it is not suf ciently distributed, the dry season being t long; but worst of all too little rain falls spring and too much during three to fo months, from June to September, when it is t frequently accompanied by dense mists oft obscuring the sun for a week, sometimes mor at a stretch. There are also not unfrequent sudden heavy downpours which have be known to amount to ten inches and more in single night. These downpours as well considerably heavier annual rainfalls tha have been named are more characteristic the outer ranges. The mean temperature the "station" of Darjeeling is only a coup of degrees above that of London, but that the tea gardens is, of course, much higher. the Terai and confined valleys under 2,000 fe on the hills it is quite tropical and ofte stifling. At elevations of 4,500 feet the ten perature seldom exceeds 85°, the mean max mum about 80°, and at elevations of 3,000 fe it occasionally turns 90° with a mean max mum of about 85° in the shade during the h months. The mean maximum in the shade i winter is about 60° at 4,500 feet, and 67° 3,000 feet. The difference between the mea maximum and the mean minimum varies fro 15° to 20°, and more in winter than summer, and at high than low elevations. A registers have been kept since 1866 for th company I served in Darjeeling for thirt years, and for the last eight or ten years at n less than eleven stations, at various elevation from 1,400 to 6,300 feet, the statements in th appendix are given to avoid further detail here.

The latest complete Government returns tha I have been able to obtain give the entire are of the Darjeeling district as 1,234 square miles about equal to that of the county of Stafford The old hill territory, containing the well known tea gardens, is put at 477 square miles the Terai at 271, and the Daling-hill distric at 486 square miles. Of the whole, 438 squar miles were returned in the possession of th Forest Department, 397 miles as held b native cultivators for cereal crops inalienabl for tea as far as the hills is concerned, 7 miles had been allotted to the Governmen Cinchona Department, and 329 square miles as grants for tea cultivation. It will, therefore, appear that but one-fourth of the whol has been allotted for tea, and that certainly no



Walker & Boutall sc.

more than one-thirteenth or about seven and a-half per cent. of the entire district is actually bearing tea at the present time. From information kindly furnished by the India Office I find the area of the district is now stated to be 1,164 square miles, and the difference may be due to the portion marked off and included in the Dooars district some years ago. I am also of opinion that for tea, transfer of some of the land returned as above for native cultivation may have taken place in the Terai. Yet if this be so, the proportion of the tea grants would not be greater than stated. Seeing the Census of India Report, published in 1893, gives 242 square miles as the area held for tea estates, I cannot be charged with any desire to understate the proportion allotted for tea. Hardly any land on the hills suitable and available for tea remains unplanted.

The more recently-acquired district of Daling may be taken as about equal in extent to that of the entire original Darjeeling hill territory, and generally comprises much gentler slopes. Of this 250 square miles are returned as made over to the Forest Department, 30 as retained by Government for cinchona, and 141 consisting of beautiful slopes, most desirable as a place of residence for Europeans, and as suitable a district for European colonisation as can be found anywhere in the East, has been reserved by Government for natives, and is now largely in the possession of Nepalis, who are aliens, and a smaller proportion of aborigines and semi-aborigines. About 65 square miles of this sub-division was reserved for tea, but so unsuitable was it that, notwithstanding the eagerness for tea grants, especially in the hills, only about eight or nine square miles had been taken up when I left India in 1893, and hardly more than about 1,200 acres altogether have been opened out. These new gardens adjoin the Dooars, and may be said to belong to that district rather than to Darjeeling.

The late Dr. Archibald Campbell, who was an active and enthusiastic member of the Indian Section of this Society, was the first resident Government official at Darjeeling, and did much for the district in its early years. He was removed from the Residency at Nepal to be Superintendent of Darjeeling in 1840, and in 1841-42 he made the first trial of growing tea in the district. He continued his experiments, and in 1847 had the plants raised reported on by a gentleman from Assam, which fully confirmed him in the opinion that tea could be grown successful on the hills. Seed was distributed by Gover ment to several residents most likely to justice to it, and experimental plots of a fe acres were planted out in different localitie about 1856; and in 1857—or it may have be a year earlier as asserted by some—the fir tea garden, on an extended scale or co mercial footing, was started at Alloobaree Major Samler. In the Terai, though exper mental plots were planted earlier, the fir garden (now known as Chumpta, near Kaprai was opened out about 1862 by Mr. Jam White, one of Darjeeling's pioneer planter then a most energetic man, who had previous planted, in the course of two seasons, ve successfully, Singel, near Kurseing, still o of the largest, if not the very largest, of o single hill gardens. Darjeeling has sinc grown gradually in importance as a tea-pr ducing district and in other respects. A present there are about 175 tea gardens in th district, extending to about 55,000 acres unde plant, giving employment to not less tha 70,000 natives, excluding children and othe non-workers.

According to the last census returns, th rapidly-increasing population of the distric was 94,712 in 1872, and 223,314 in 1891. O the latter, 88,021 were stated to be resident who were actually born in Nepal. This bein so, the Nepali population of Darjeeling wh have immigrated at one time or another, o been born in the district, can hardly be les than 160,000.

Tea is certainly the staple, if it may no claim to be the only, Darjeeling industry, an to say the least, has done much for the dis trict. The 1895 crop amounted to 10,771,11 lbs., of which most went home, contributing considerably to the exchequer, benefiting trade in many directions, and supplying nearly al the return traffic to the local railway, at highly remunerative rates, considering it is conveyed downhill mainly by gravitation. Very little produce of any kind is exported, or even supplied to the district, from the native holdings.

In regard to my main subject, the first point requiring attention naturally should be the selection of a site for a garden. This is a matter of vital importance, and calls for the exercise of much judgment and experience, and often exhaustive labour in exploiting. The soil may be looked upon as the constitution, so to speak, of a garden, upon which its prosperity and staying power mainly epend, and its selection, especially as the ubsoil, to a great depth, is of importance /ith a deep-rooted plant like tea, involves o light responsibility. Besides a wholesome ater supply, forest, water-power, and, in the lains, immunity from flooding should all, if ossible, be secured. But as this can no onger concern Darjeeling hills, there being o longer grants available for tea, it need not ere be dwelt upon at length. Though I have een concerned with the opening-out of gardens f considerable extent on Darjeeling hills, I ave never had the responsibility of the selecon of the grants for them, but have merely ad to endeavour to make the most of the round at my disposal. The orginal Darjeelig gardens were, as a rule, selected and pened out in a creditable manner, consideig the experience of the time. During the ania of 1863-64 extensions were pushed on pon risky and unsuitable soil, beyond the abour and experience available; the land was ery imperfectly prepared and planted; there ere difficulties about seed; seedlings had ften to be carried long distances, necessarily esulting in failure and consequent abandonent for a time. A proportion of the land hen abandoned has gradually been re-opened uccessfully under more favourable conditions. f a grant of land has still to be selected on he hills, the most important consideration ould doubtless be to secure a soil that would ield quality, and varying in elevation from ,500 to 5,000 feet. All aspects grow tea lmost equally well; and though the southern nd south-eastern are drier and more difficult o plant successfully, they are, upon the whole, referable when opened out. The northern spects require less care and less skill, and re not so risky for vacancies, but have comaratively more in their favour at low, dry altiudes than high. Though gentle slopes are ndoubtedly preferable, they have generally, n that very account, been much more under ative cultivation; and, contrary to the expecations of many, the steeper—often extremely teep—ground grows the better tea bushes. It hould here be noted, in regard to these hillides, that it is very difficult to get tea to thrive pon the sites of homesteads, and that for nany years those parts generally remain bald, omparatively bare looking, and an eyesore pon an otherwise successful garden. But I an bear testimony to the fact that such atches, after having been trenched to an nusual depth, kept fallow, and sulphured nnually for three years, have afterwards been planted quite successfully, the tea bushes flourishing and keeping pace with the body of the garden from the outset. Further, all land long under native cultivation should be allowed to lapse into jungle, or, as it were, lie fallow for three or more years, and, of course, the longer the better before planting.

The first operation in tea planting is the clearance of the land; it may be from forest, but often upon partially cleared and cultivated or grazing land. In the case of forest toon and a few other very valuable trees, the drip and shade of which are least injurious, they should be marked for preservation at considerable intervals. The felling of trees is a work the Nepali is expert at, and delights in, his bump of destruction being highly developed. The trees are sometimes prepared so that the fall of one carries others over with it, and so on continuously down the slope like ninepins, with a crash that resounds through the solitude of the hill-sides like muffled thunder. After the storage of useful timber, the next step is the burning, over which there is considerable excitement. This is carried through as soon as the clearance has been duly prepared and become sufficiently dry, advantage being taken of a safe and suitable wind. A great number of coolies have to be in attendance to guard the fire from spreading to property beyond. In addition to wood and other growth there are often numerous bamboos upon the clearance which, when being burnt, crackle and give forth reports resembling the roll of musketry, while the figures of the natives flitting athwart the raging flames, and by times being taxed to their utmost to keep the "burn" within safe bounds, render the scene a lively one, though not always free from anxiety to those responsible. The burning stumps and heavier bamboos often smoulder for days.

After the fire has died out the ground ought to be trenched and thoroughly cultivated to the depth of 18 inches throughout the gentler slopes, but effectively though carefully and to a lesser depth on the steeper slopes, and in accordance with the degree of steepness—extracting stones and all roots of trees, bamboos, jungle and weeds at whatever cost. On such steep and irregular ground much judgment and ingenuity have to be exercised in order to direct the surface drainage into safe channels to prevent "wash." All except the gentler slopes ought to be carefully terraced. These terraces should not be formed too elaborately, with a deep well behind, and built up sharp

angular edges in front, or containing two rows of bushes alongside, as they sometimes do, but merely so as to modify the slopes no more than necessary for the stability of the soil and prevention of wash. This is more simply accomplished if attended to at the proper time and place than it would appear to be. A shallower formation of terrace will interfere less with the capillarity and natural circulation in the soil than the more elaborate. The deeper and more acute angular terraces greatly intensify the defects of the Darjeeling climate. The terraces should also be aligned as far as practicable to direct the surface drainage into safe channels. It stands to reason that the wash should be diverted near its source, and as it begins to accumulate. Paradoxical though it may seem, it is not generally the steepest parts that suffer most, but the gentlest slopes even where they assume almost the form of a plateau. This arises from the surrounding slopes having acted as a filter, so to speak, concentrating a rush of water upon such after sudden downpours. The object of surface drainage is to check this accumulation, and the drains should be laid off with a gentle run. The excessively steep portions should be laid off in "spot" terraces, formed in the most advantageous places, to contain one or more plants. The laying off of the estate roads so as to traverse all parts of the gardens, without involving waste of locomotive power, is important, and their alignment should also be such as to aid in the safe drainage—the reverse being easy. This somewhat difficult task, with the skill and experience available in the early times, was not so invariably successful in attaining the perfection and easy uniform gradients as desirable. The prevailing gradients of garden roads, except where crossing the slopes or rounding ridges, are from 1 in 7 to 1 in 5, width 5 or 6 feet; but paths are to be found not more than 4 feet wide, and so steep as to ascend or descend 1 in 3. A sure-footed pony — which the Bhooteah ponies generally are — is indispensable; and passing across precipices with a sheer drop of hundreds of feet upon such roads is trying to the nerves of most unaccustomed to mountain travelling. As has been remarked, the length of road is great in proportion to area. By careful survey, I have ascertained that on a garden of 500 acres, benefiting by the service of a district road zigzagging through its entire length for 4½ miles from top to bottom, the inadequate system of estate roads measured 18 miles,
leaving fields of tea very arduous to rea
from any of the roads. The Ceylon "ro
tracer," a simple and inexpensive, but a
mirable, instrument, is a most valuable aid,
the inexperienced especially, for the alignme
of roads, but, in my experience, even more
in the laying off of terraces. Roads general
like terraces, should have the outward, n
inward, slope, but may also have a dra
along the inner or hill side when require
The removal of stones, as referred to, mig
possibly be carried to excess in rare instanc
but of this the risk is not great. I have oft
had this done to an enormous extent, and wi
an unfailing corresponding advantage on e
tensions. The stones may be disposed of f
buildings, or in forming embankments, cu
verts, and fords for roads. Besides, when
road passes through good land, the rich s
may be removed and spread upon the poor
parts of the garden, and replaced with stone
The remainder of the stones can be built up
heaps upon spots of convenient waste lan
The cultivated area has to be lined a
"staked" off for planting, and no litt
ingenuity and care are required to get t
points for the plants arranged in perfect
straight lines up and down a steep, irregul
hill side, "over hill and dale," and, at t
same time, getting them to fall into co
touring lines along the terraces, without lo
of space or overcrowding. Opinion has alwa
varied, and from time to time vacillate
as to the distance the bushes should b
planted apart, and though there is a guidin
principle in regard to this, it may not be we
to dogmatise. For the hills, I would ventu
to recommend 5 feet × 4 feet, 4½ × 4½, and a
the closest 4½ feet × 4 feet on the base, bu
for the Terai greater distance, especiall
between the rows, to admit of ploughing o
horse-hoeing if found necessary.

There are two modes of planting, the on
from nurseries by transplanting, the other b
putting down the seed germinated or fresh i
situ, or, as it is termed, "at stake." Eac
has its own advocates and advantages, but i
the climate of Darjeeling the former is prefe
able; besides, two paramount advantages ma
be claimed for it anywhere—namely, five o
six months more are available for the thoroug
preparation of the ground, and it admits o
the perfect selection of the most vigorou
seedlings of the best and of uniform variety
Moreover, from my own observation, I hav
often been disposed to doubt whether th
quality of the produce is not improved by th

ansplanting. This may not be so, but I ave been at a loss otherwise to account for e different quality of tea in adjoining ardens on similar soil, and under varying anagement. This is a matter I would commend to practical men, as worthy of eing determined by systematic experiment. the transplanting is to be adopted, an xtensive and elaborate system of nurseries is ssential. For nurseries, the most advanced arden cultivation, constant care and attention re indispensable, watering in most instances, nd shading in hot-exposed situations being eedful. The nurseries should be numerous, nd if practicable, in or near all parts of e proposed extensions, for economy in the arriage of the seedlings. The seed beds ust be thoroughly freed from stones, and the eed should be sown rather wide apart, specially when machine planting is to be dopted. Though 4 inches × 4 inches may eem too close, judging from what is generally ritten, that in practice will be found to work ut satisfactorily, the early and first season's perations thinning out, and giving space for e young plants that remain.

The seedlings are generally removed from e nurseries at the age of from six to eight onths. They should be transplanted with balls f their own earth attached to their roots, and is can be accomplished to great perfection y Jaben's patent transplanter, an ingenious achar invention, simple in operation, handy, nd costing a mere trifle. All risky dry aspects hould be planted by this means, and also uring the most seasonable and favourable eason and weather. Most northern aspects, nless during unfavourable weather or towards e close of the season, may be planted very uccessfully by hand with a lighter quantity nd less perfect ball of earth attached, at a aving of labour. By this method the seedngs receive no check to their growth, while ose put out in the old ordinary defective ay, without earth attached, with difficulty xist during the ensuing dry season at the est five months in duration—some years, even ight months, from October to May inclusive. Vith land thoroughly prepared and planted ut as referred to, though much more costly e first year, this will be more than comensated for in the saving upon the cultivation subsequent years; while, it may be safely sserted that as good growth has been btained in three years in this way as was ommon during five years under the ordinary ethod.

It must readily be perceived that the judicious cultivation of such excessively steep ground must be a matter of vital importance. The utmost foresight, ingenuity, and care are necessary to prevent the soil from being carried downhill, not so much in the process of hoeing itself, as by the action of the heavy rainfall, especially the sudden downpours early in the rainy season. Forking is much less dangerous for injuring the roots of the tea, and is much safer for hill cultivation than hoeing with the country *kodalie.* Moreover, the straight digging fork admits of the labourer standing upon the unturned ground, and turning or tossing the soil up-hill; while in hoeing he reverses the process, by trampling the ground he has just cultivated, and dragging the soil down the declivity. Cultivation by means of the straight digging fork was first advocated and experimented with in Darjeeling by the late Mr. John Stalkartt. Forking was resorted to on a large scale by me 23 years ago, and is now pretty general, the hoe (*kodalie*) being only used in the preparation of extensions, road-making, and the like. It is, however, decidedly, more costly than hoeing, which is a consideration, when labour is scarce, and many hundreds of acres are entirely under spade husbandry, so to speak. The deepest and most important cultivation of the year is the cold-weather digging. This is but too commonly done by turning the ground up rough, and leaving the whole in large clods. Such a process is highly objectionable, in a climate like Darjeeling, with a long, trying, dry season, and too subject to droughts in spring. It is, of course, quite different in Britain, where the soil exposed in a similar way is pulverised by the action of frost, and there is in general an excess, rather than otherwise, of moisture in winter. But this rough cultivation aggravates the defects of the Darjeeling climate, and intensifies the drought; while the clods, by the scorching action of the sun, get dried and baked like so many bricks, especially in the southern and dry aspects. In all countries subject to droughts, especially in the tropics and sub-tropics, a thorough cultivation and pulverisation of the soil throughout, but especially at the surface, in autumn and the dry season, is by far the best for attracting and retaining moisture and obtaining healthy crop growth. Thorough cultivation admits of ample aeration of the soil. This is a subject which I have given much thought and attention to for 30 years. Shortly after I went to Darjeeling, I experimented with rough and thorough cultivation, on equal plots alongside, noting the result as to benefit derived from dew and retention of moisture, and can entertain no doubt as to the immense advantage of the latter system over the former. While making my farewell tours through the district in the spring of 1893, field after field, in different localities, came under my observation, lying exposed to the scorching sun in clods, in some instances almost half the size of a man's body, and I could not but sympathise with the proprietors. For the second and succeeding cultivation at the close of spring and the early part of the tea season, hand-weeding is the most suitable and stimulating culture of all; and as an accompaniment the weeds or grass can readily be disposed of in layers or bands across the slopes, and (drainage having been attended to as referred to) check the "wash" in a wonderfully effectual way, even where there are no terraces. Hand-weeding may be carried on most advantageously, especially where extensions have been thoroughly prepared. In the rains, when hand-weeding has become impracticable and a turf has formed, the soil may be forked over less deeply and left rough, there being no longer fear of drought, and less from "wash." After an extra wet time, or on unsafe parts during the rains, nothing more should be attempted than close sickling, supplemented by hand-weeding, of spots around the collar of the roots of the plants.

The great difficulty attending the perfect cultivation of a tea garden during the rains is that the crop must be gathered at the same time, and there is often pressure to get the leaf off at the most perfect stage. The time, nature, and amount of cultivation has, therefore, but too often to be regulated by the labour available for it. Forking ought to be avoided in excessively wet times, and done in favourable weather, but for the reason just stated, it is impossible always to choose the best time, unless the labour force be unusually strong—stronger perhaps than might prove profitable where coolies must be retained all the year round, as is the rule, and cannot be engaged for a pressure of work, and their services be dispensed with when it is completed. Extensions and building upon an old garden are also liable to retard garden operations and add to a manager's difficulties and anxieties. Unfortunately, the real question is not to know what ought to be done in regard to cultivation, but too frequently what is practicable with the available labour. What has, in many in-
stances, become a most vital matter on th
hills, is how best to rectify the results of reck
less or defective cultivation on old garden
during the past. This is sufficient to tax t
the uttermost the skill and resource of th
most ingenious, and in some parts, not t
speak of impaired cropping capabilities, s
grave has the evil become that the onl
effective remedy would be to carry back th
soil from the valleys and hollows where it ha
in process of time been washed. Terracin
an old garden originally lined up and dow
hill, and often laid out in hedges without an
such object in view, has its drawbacks. Th
plants that fall in the backs of the terraces g
their roots bared too much and injured, an
those in the edges are unduly buried.

Ploughing is impracticable anywhere on th
Darjeeling hills, but in the plains distric
might with advantage be resorted to, and
daresay has been for the preparation of exter
sions, but whether steam ploughing has bee
resorted to or not I cannot say. About 2
years ago I tested light ploughs by Ransom
and of native pattern on a mature garden i
the Terai, but the work was not fine or th
result satisfactory. For the plough the dis
tance between the rows would require to b
wide, but in spite of this the lateral roots o
the tea get damaged, and the cleaning clos
to the stems must be done by hand. Th
injury to the roots should to some extent b
obviated by trenching all over as recom
mended on opening out, but ploughing on
planted garden is never likely to prove s
advantageous as hand labour when procurabl
at moderate cost.

The manuring of the tea plant is for man
reasons difficult, but fortunately the matter i
not yet a pressing one generally, the tea cro
being neither heavy nor exhaustive, and mor
nitrogen is undoubtedly returned in the rai
than in more temperate climates. The aver
age crop of green leaves taken from the soi
annually does not exceed 12 cwt. per acre (sa
half-a-pound per bush) which is very triflin
compared with the weight of agricultural crop
in this country exclusive of the portions thereo
returned to the soil. Some attendant draw
backs to tea manuring are want of an adequat
supply, costliness of transit, liability to evapo
ration and waste, and, tea being a deep-roote
plant, the difficulty of applying the manure s
as not to increase the growth of the weed
rather than leaf in the first instance. It ha
not been proved even how manure may affec
quality, which is an important consideratio

nd must depend upon the nature of the nanure used. By all means let every available manure, solid and liquid, be preserved rom waste through exposure—the danger of vhich is very great in a tropical climate—and e applied to the best possible advantage. But f all that is practicable in this line I attach nost importance to "green manuring," by neans of turning into and burying in the soil n autumn the greatest possible amount of resh and decaying growth. Let this work be ushed forward with the utmost vigour with all available labour. Nothing else in the way of manuring I know of can give so good a return. Top-dressing with leaf mould or other rich mould is also of immense benefit, and even when soil of only the poorest quality is procurable a thick dressing with that on thin dry parts has shown markedly good results. Manuring, and more so top-dressing, is comparatively unavailing—simply outlay and labour in vain—unless the application be a liberal one—three to five inches deep in the case of the latter according to quality of mould.

Transport by means of wheeled vehicles, in the ordinary sense of the term, is quite impracticable on any Darjeeling hill road except the main military one, where cart traffic has been superseded by the wonderful Darjeeling-Himalayan Railway, and on one or two other pieces in or near the "station." There are no lakes or navigable rivers as in Kashmir, and previous to the torrents being permanently bridged ferries even were not practicable except at one or two points in or near the Terai, and they were always attended with some danger.

All carriage, including that of ordinary building materials, fuel, and provisions, is performed upon men's backs, and journeys are performed by pony, on foot, or, in the case of ladies, children, and invalids, in chairs or a form of hammock called a "Dandy," suspended on poles and carried by coolies. Heavy loads, such as boilers, tea, lead, and sometimes lighter packages, are conveyed from the nearest station to the gardens by trucks or trollies mounted on low broad-rimmed wheels. The bringing down of a 20 or even a 10 horse-power boiler of several tons weight is one of those little incidents that break the monotony of garden labour. Some skilful steering is needed in turning the acute corners of the zigzags, and in guiding the passage safely over many precipitous parts of those steep, narrow mountain paths. As many as 100 of the strongest men may be employed with a truck so freighted, chiefly strung upon ropes—some pulling before and others behind, as occasion requires, the latter to prevent the truck getting beyond control by acquiring too much down-hill velocity; others using crowbars, planks, or other appliances as need arises. In Assam and other plains districts of India and Ceylon, elephants are employed for the dragging of boilers, presenting scenes hardly if at all less picturesque.

In regard to buildings, time will not admit of my entering into detail. In the past the planter has been his own architect and clerk of works, planning, estimating for, and vigilantly superintending every operation from the sawing of the timber in the forest, the making and burning of the bricks, to the completion and full equipment of the edifice. The more modern and doubtless the most extensive buildings are in the plains districts of India and Ceylon, where extensions on an enlarged scale have been more recent; there in addition to the most modern mechanical appliances electric lighting has been introduced. In Darjeeling there has not been the same scope. The buildings had generally to be designed to suit the sites after costly excavation on the steep hill sides, and in the case of amalgamation of factories, for instance, ingenuity had to be exercised in the erection of a main central building to connect two others at different elevations, the ground floor of the one being near, but not on the identical level with the first floor of the other. The whole had to be designed for convenience, to deal with increased crops, and meet modern requirements. The managers' bungalows are generally charmingly situated, little being required, in the shape of landscape gardening, to make the surroundings altogether beautiful. These buildings, with their white-washed walls and shining roofs, studded over the hill-sides surrounded by the green tea gardens, present to the traveller at all points a striking and pleasant feature of the landscape. Many of the dwellings of the garden labourers are substantially built with brick walls, corrugated iron roofs at the higher, and thatch for coolness at the lower elevations, and verandahs in front. The floors are well raised, and space, convenience, comfort, and sanitation are provided up to and in most instances in advance of the tastes and wishes of the occupants. Few of them would tolerate fire-places, or the exit of the smoke by chimneys in the walls; but on account of warmth, or for other reasons best known to themselves, prefer it finding its way from the centre of the floor through the ventilators in the roof, as in Scotland, within my own recollection, and I daresay in other civilised countries. Many darken or block up entirely the windows provided for them. However, the modern coolie dwellings are a very great improvement upon the huts once universal, and in most cases all is being done for the coolies' comfort that is practicable or at present wise. In the centre of the village there is generally a level plot reserved, though difficult to obtain, as a recreation-ground. One moderately-sized company has already erected so many such permanent coolie lines that if placed end to end they would extend to over two miles.

The view now shown on the screen includes a group of buildings comprising sub-manager's bungalow, factory, with coolie lines in the background, to all of which pure water is conveyed from a stream on the opposite spur of the mountain two miles distant, by means of galvanised iron pipes passing through a deep ravine, where there is a pressure of 1,175 feet head of water at the lowest point. The company to which this small estate belongs has water laid on in pipes to all their coolie lines, where needful, factories and bungalows, having in operation for this purpose, as near as may be, seven miles of galvanised pipes of various bores, fed from filtering beds and fountain-head tanks, and discharged into numerous large cisterns, from which, and from "standpipes" convenient, all, including the coolies, are constantly supplied. Besides, this company has a supply of fire-hose fitted to discharge water with force at the highest point of the factories, and, in one case, at least, out of three, with pressure sufficient to eject it over the roof of a three-and-a-half storey house, the hose meanwhile being held in the hand on the ground. And, to convey some idea of the extent corrugated iron is in use on tea gardens, I may mention that the company referred to, though by no means the largest in the district, has in all imported 4½ acres of that material for roofing its own buildings.

The operations of tea manufacture are now performed by machinery in all factories of any importance. Steam is the commonest motor, but water-power (mainly by turbine) is also in use. In the case of the Tukvar Company, the turbine is situated in a ravine about two-thirds of a mile from and 1,500 feet below the level of the factory, the power being transmitted to the machinery there by means o wire rope, travelling upon pulleys supported on standards placed at suitable distance apart. The district owes the conception and accomplishment of this bold and arduou undertaking to the ingenious, indefatigable and praiseworthy efforts of the late Mr. Thomas B. Curtis, of Tukvar, a well-known and mos able tea planter. On another hill garden electricity has for some time been employed, the turbine and generating apparatus being similarly placed beside the torrent far below and distan from the factory and machinery to be driven For this laudable pioneer object-lesson in regard to the motor, which I believe to be specially suited and destined to be the power of the future for Darjeeling, we are indebted to the late much-lamented Mr. William Lloyd who also rendered many public services to the district in the promotion of her marvellous little railway, botanic garden, public park municipal affairs, volunteering, local banking and the like, fully appreciated by few, and never adequately acknowledged. Through his enterprise Darjeeling has been for 30 years conspicuous as the only tea district as such, as far as I am aware, possessing a European bank.

To return to the field operations, a few remarks are called for concerning the pruning, which has to be attended to as early as the young plants betray a tendency to run up too much and assume the habit of a tree rather than retain the form of a bush, in the case of vigorous seedlings at as early an age as two years, and even younger where individual specimens show exceptional growth; that is, if the planter believes, as I do, in training the bushes when young, but opinion used to vary on this point as on much else connected with the industry. After the plants have attained three years of age, they are all pruned according to their form and condition annually. The object of the operation is to get rid of the knotted unproductive wood, to thin out slightly to admit air and light, leaving the young vigorous leaf-producing branches and shoots, to train the bushes to width—to give flushing surface, the leaf being gathered mainly from the top—and to keep them at a height convenient for the coolies to pluck the leaf from. Great caution is necessary in regard to heavy cutting in Darjeeling. The pruning is a work requiring a great deal of labour annually, and as many untrained coolies have to be employed, it demands close and constant supervision. The pruning season, as a rule, lasts from the end of ovember till the beginning of March, but the ore that is done from Christmas till early in ebruary, the better.

Need I say, that tea is not made from the d, matured, or even hardening leaf, but only om the undeveloped bud and the young and ost succulent leaves at the point of the rowing shoots? In early times three, some- mes four, if not occasionally even more leaves ere gathered, but more recently quality has ecome more and more the aim annually; and ow it is the common practice to take only vo leaves and the bud, but in some instances lucking is so select as only to embrace one af. The bud yields the finest tea of all, *i.e.*, ie "golden tip" or "silver tip," the top leaf rming the next quality, "orange pekoe," r, when large, "pekoe," and the second or wer leaf generally yielding pekoe, but 'pekoe-souchong" when the leaf is large. ommonly the first shoots of the new growth f the season bearing four, five, or six leaves o to make up what is termed the "first flush." he two top leaves of this, or in some in- tances only one leaf with the bud are plucked —that is cut off with the incipient tender stalk etween the finger and thumb—for tea; the emaining leaves and stalk being too far de- eloped for quality and necessary for the health f the bush, and the giving out of subsequent 'flushes" are left. After the first flush, less resh growth requires to be left, and after three r four months of discriminate, sparing cropping, the bushes having become sufficiently nade up and fortified for the season, all the fresh growth that will make tea of prime quality may be gathered without risk of injury to the plants. The pluckers have to go round the gardens at intervals of from five to eight days, extended from nine to eleven days towards the close of the season, according to elevation. It is the pluckers' duty to avoid gathering too coarse leaves or unripe shoots, to miss no good, suitable leaf, and prevent the heating in the baskets of all that has been gathered. In plucking, much discrimination as well as dexterity is necessary, and though perfection may not always be attainable with many hundreds, including often a proportion of untrained pluckers, employed, the operations over the scattered fields on those steep rugged hillsides require all the more unremitted attention and arduous supervision to obtain the most satisfactory results practicable. It is well when the leaf can be delivered at the factory twice during the day, but this is not always advantageous when the range of elevation is great. On plains gardens this is comparatively easy, light tramways being occasionally in use for the purpose. The cropping season generally lasts from the end of March till the middle of November. The crop varies from eight to fifteen cwts. of green leaf per acre annually, which yields barely one-fourth its weight, say from 200 lbs. to rarely so much in the present day as 400 lbs. of prepared tea per acre.

The first operation at the factory is the weighing of the leaf. Here it is necessary finally to examine the quality and condition of the leaf brought in from the field. The pluckers are occasionally paid extra for what is gathered in excess of the allotted task, and if a shrewd inspection of the contents of the baskets were not made, in addition to leaves of inferior quality, a stone or other foreign substance might occasionally be concealed amongst the leaf to increase its weight. The leaf should be delivered green and fresh, but it is often wet, in fact this may be said to be its normal condition in the rains.

Thence the leaf is conveyed to the withering rooms or sheds which are fitted up with tiers of broad shelves of wire mesh, Hessian cloth, or bamboo netting, at heights and distance convenient for handling the leaf. The leaf should be spread out thinly, and the more extended the surface provided the better, up to say eight superficial feet per lb. of leaf. It is most desirable to have a free current of air to pass over and through the spread-leaf, and to cause this air propellers, known as "Blackman" fans, or others of similar description, are extensively used. Natural air is most desirable, but when the leaf is wet, the weather misty, and the atmosphere saturated with moisture, as is often the case, air slightly heated, and as far as practicable dried artificially, has to be applied instead, and it is under such conditions that the fans do much to facilitate and quicken, and prevent loss and injury to quality from unduly protracted operations, especially in the case of high-class hybrid leaf. The function of the fans should be to distribute the dry hot air and give ventilation over a wide area. The withering process is a very important one, it should not be done too quickly, and the great aim with it is to obtain fragrance, to avoid heating or discolouration of the leaf. By it the leaf should be brought into a flaccid state. This prevents its breaking up in rolling. Withered leaf to the feel resembles that of a fine kid glove. The process generally lasts from eight to ten hours in all. Wet leaf should be the more slowly withered, but ought not to occupy more than fourteen hours unless the weather be very unfavourable, and artificial heat be not resorted to. The leaf leaves the withering stage of manufacture limp and flaccid, still green, but of a slightly duller hue, and ought to be fragrant.

The next process is rolling, which is performed by machinery. There are several rolling machines by different patentees, each having their own advocates. The best known and most generally used are the Jackson machines, especially the "Rapid," which performs the work of about 70 men and does it to great perfection. By an ingenious arrangement of cranks, &c., an eccentric motion with elastic pressure (resembling that of the old hand rolling) is produced between a table and a box above which usually contains as much as 300 lbs. of withered leaf at a time. This upper plate or rolling box is generally of metal lined with wood, but also of granite or marble for greater coolness. The lower rolling surface or table is usually of wood, but is sometimes granite or marble-faced. This machine is beautiful though simple in movement, and as a roller as near perfection as can well be conceived. The leaf is usually rolled from 25 to 35 minutes according to quality of leaf and the views of the manager, then sifted on wire mesh sieves to separate the fine from the coarser, which at the same time aerates it and breaks up the balls. The fine and coarser leaf are after this rolled again separately for from 10 to 15, and from 25 to 35 minutes according to quality, and under such pressure as desirable for each. Machines are also designed and supplied specially for sifting, disentangling the balls, and aerating the rolled leaf. The withered leaf is fed into the hopper of the roller from the loft above by means of a canvas shoot, and the rolled leaf is discharged through a trap underneath into a trolly which conveys it to and from the sifter, and finally to the fermenting room. It must here be noted that the leaf on leaving the rolling machine has had its cellular tissues broken, has received a twist or "roll," and is a wet pulpy mass but still green.

Now follows the "oxidation," commonly termed "fermentation," without exception the most important process of manufacture. The rolled leaf having been sifted as referred to admits of the fine and coarser being oxidised separately, thus securing a greater uniformi of result. The fermenting room should be i the most shaded situation, and might in fact b partially—in some instances entirely—unde ground in the hills. The leaf is spread upo tables, or it may be on tiers, of ledged shelve resembling shallow empty bunks in a pa senger steamer but at convenient height, i layers 3 to 4½ inches in thickness according t the temperature of the day and other cor ditions. Every means should be used to kee the leaf cool. It is kept covered with we cloths, and surrounded by screens kept wet b constant syringing. The floors and surroundings are also syringed with water. I am unabl to say how far refrigerating apparatus migh be adopted in the fermenting rooms with goo results. This has been thought of by a Darjeeling manager, long a fellow-worker wit me. I am, however, enabled to testify as t the best quality having been obtained at th coldest season, and when the oxidatio occupied an unusually long time. The grea secret is to be able to check the oxidation or incipient fermentation at exactly the righ stage, as quality will be unfavourably affecte by underdoing it or overdoing it. The time occupied varies generally from 3½ to 5 hours but 5 or even 6 hours towards the close of the season and at high elevations is nothing unusual. A great test of the result is when a bright salmon colour resembling that of a new penny is obtained in the mass. It is important here to observe that the leaf entered upon the oxidation process, green and wet, but leaves it for the next, which is drying, a bright salmon colour and slightly less moist.

In former times the leaf at this stage underwent a process called "panning," which for many years has been entirely dispensed with. In this the leaf was turned over and tossed about in highly-heated iron pans by the operators' hands, aided by a forked stick. This was the most trying process of all for the "teamen," and unless it had some advantages in regard to the keeping or other properties of the tea—and it would seem impossible for any one positively to assert that it had not—it is well it has been abandoned, as it was a dirty, troublesome, risky process, calling for the consumption of no little fuel. After the panning (which occupied the position of the sifting referred to) the leaf received a second and final rolling.

There are several tea-drying machines. The best known are those patented by Jackson and by Davidson. But each machine finds its vn ardent advocates among producers and ieir managers. Jackson's "paragons," his test inventions in this line, are like some of is others, automatic in their action, and, as ieir name indicates, work to very considerble advantage. By these machines the leaf passed through a chamber filled—by means f a fan—with a current of air heated to a mperature of 240° to 250° (reduced to, say 00°, for finishing), on a travelling endless eb of perforated zinc sheets or "flappers," hich convey the leaf backwards and forwards rough the drying chamber, turning it over t either end, in all, seven times through its ntire journey. The wet leaf is fed in at the p, and there is a continuous discharge of e dried tea at one of the lower ends of the achine. Davidson's dryers are worked by eans of wire mesh tray drawers, containing he leaf, which are pulled out to have the leaf urned over, and are pushed back again into he heated chamber, and this process repeated y hand (with the aid of levers), to meet reuirements and the views of the manufacturer, is "down-draft sirocco" being worked with he "up-draft sirocco" without a fan. This rocess—especially the finishing off—should ot be performed too quickly; it ought to ccupy, say, two hours. The mode of desiccaion just superseded by machines, and which as all but disappeared, was that over charcoal ires in brick-work furnaces, with wire mesh rays worked by hand. The original method f drying, as practised by the Chinese, and for ears in India, was still more primitive. It vas by bamboo mesh trays, placed on the top f light wicker-work cylinders of the same naterial, encircling small charcoal fires placed n holes in the floor. These cylinders stood bout three feet high, and were narrower in he middle than at top or bottom, resembling n shape some wooden egg-cups of the olden ime. The leaf goes into the dryers a salmon olour, but in the process of drying it changes olour, and is discharged from the machine or other process) dry, crisp, and black, and ts twist has become more perfect and wiry; n fact, it is now practically the tea of commerce, "unassorted," only requiring to be sifted into "classes."

The classification of the tea is performed by machines, by means of wire mesh of different gauges, receiving the unassorted tea above, and discharging it as "broken pekoe," "orange pekoe," "pekoe," and "pekoe-souchong" from shoots into their respective compartments below, in which boxes or other receptacles may be placed to recei different classes. The long recipr sieves, though cumbersome, have no fault I know of, and are simplicity consisting merely of a succession of w the required mesh placed end to en charging the various classes into recep placed underneath, the large leaf e dropped over the end.

From some of the classes thus obt especially the lower grades, a few co leaves, stalks, or stray foreign substance have to be picked out, the operation impracticable by machinery. But a bright, tidy Nepali girls soon give those finishing touches, which hardly amoun handling in any degree. For this the tea, an expert jerk, is placed upon bamboo tra the contents of which are turned over fr time to time for examination, and the requir sorting out very deftly performed with delic pliars, simply formed of two slim spring splints of bamboo ingeniously joined togeth r

The time occupied by the entire process manufacture as now described is generall from 22 to 26 hours.

The final process is packing. To do thi daily as the tea is made has but little recommend it, but if it were otherwise, it i not always practicable. The insuperabl objection to this arrangement, however, is tha one day's manufacture, even when the sam in appearance, differs unaccountably in qualit and character from that of another, and th contents of one chest, must therefore, as a rul be different from that of another in the sam break, entailing bulking at home with its con sequent damage to the tea, and extra expens All tea, I hold, ought to be bulked at th factories, where alone the operations can b performed to perfection. For this purpos each class, on being assorted as just referr to, should be put away in a separate b daily, and retained there till thirty, fort sixty, one hundred, or more chestfuls, accor ing to the size of the factory, accumula These bins, of course, must be in a situation, zinc lined, with closely-fitti hatches above and doors below, and perfect air-tight all over. The bins should also be carefully cleaned and dried for the receptio of the tea to be poured in through the hatche It may be accepted as an axiom that well-cured tea, perfectly stored, will improve b keeping, and the larger the quantity th greater the improvement. Poured in an kept as referred to, the tea will not only ge

well mixed, but one day's make will get blended with the others, without which no bulking can be complete. Mixing alone, to obtain uniformity in appearance, is insufficient. Without the blending in this way of one day's manufacture with that of the others, depend upon it no bulking can be worthy of the name. For factory bulking uniformity of tares is imperative. To secure this, the chests must be made from evenly sawn, clean, and perfectly seasoned boards; and to more perfectly equalise the tares, the chests should all be carefully classified by weight, those of (say) 23 lbs. being laid aside for the "broken pekoe," those of 22½ lbs. for "orange pekoe," those of 22 lbs. for pekoe, 21½ for "pekoe souchong," and so on. Providing the sawing has been done with reasonable uniformity, by this means and the interchange of lids, the tares will be found practically even. But, at any rate, this difficulty of equalising tares can surely be surmounted by the use of machine-made boxes, patent veneer, or metal chests, or some similar device. When sufficient tea has been collected in the bins to complete "breaks" of the desired size, it is drawn from the lower doors, of which it may be found advantageous to have more than one or even two to a bin. This alone goes far to mix the whole. The tea is then slowly dried at a comparatively low temperature to ward off, and expel, if need be, the slightest trace of moisture, thoroughly mixed in a large heap in a dry apartment, on a canvas sheet on a clean and perfect floor, to complete the bulking. It is then packed hot in the lead-lined cases. The packing can now be done by the "Davidson-McGuire patent packer," which ingeniously imparts a rapid, short vibratory motion to the chest being filled, obviating trampling, unequal pressure, breakage, and discoloration. This machine is coming into use on the gardens, and the sooner it is also universally adopted in the London warehouses the better, not only for the above reasons, but to supply the only missing link in the entire circle of machine manufacture. This machine claims to pack so as "to preserve the even grade of the perfectly bulked tea," throughout its passage to market, which would be an immense boon to the industry. It may be an aid, however, when packing by machine—as it certainly was without—to place a thin scale inside the box (better one at either end), graduated to, say, eight, or some other convenient number of equal parts of its depth
to be filled, so that exactly the proportion
the weight to be packed shall occupy
corresponding spaces, neither more nor le
and thus secure an uniform compression
the tea throughout. This will prevent the
having to be crunched up or pressed too mu
to get the required contents all into the box
the finish, or, on the other hand, having it
loose, in the case of too much pressure havi
been applied, and the tea caused to occu
too little space at the early stage of filli
As soon as the chest has received its ex
quantity, the top of the lead lining is clos
soldered down, hermetically sealing the c
tents. Finally, the chests are marked w
stencil plates, and secured by hoopi
or otherwise for the perils of a tryi
journey by land, which, as regards stra
upon the boxes, do not even end at the port
export.

Darjeeling tea is all carried by the har
hill-men up the steep mountain roads to t
nearest railway station on the way to mark
It is no unusual day's work for a coolie
carry a tea chest weighing 110 to 130 lbs
distance of five or six miles, making, at t
same time an ascent of from 2,500 to 3,5
feet, in sheer vertical elevation. There c
be no deception about a task like that, and
cannot but have an admiration for the powe
of endurance of those who perform such a fe
Of course, these people are trained to loa
carrying and mountain-climbing from the
very infancy, and hence the peculiar set
muscles required for it are fully developed,
not actually called into existence at the co
of others, so much so, that walking on t
level, after a few miles, becomes positive
painful to them. In the prosecution of the
own trade, or on domestic affairs, they fr
quently undertake, long, arduous journey
over ridges and along and across hot valley
varying many thousands of feet in elevatio
occupying many days on end, carrying heav
loads of from 150 lbs. to 200 lbs., and over an
in addition their own food and bedding, mo
cheerfully lighting a fire, cooking and eatin
their scanty meal, and going to sleep by th
wayside. There is a story still current of
Bhooteah in old times having carried a gran
piano up the hill to Darjeeling, a distance o
50 miles forward, and involving a rise of ove
7,000 feet in elevation by the old road. Thes
hill tribes are a hardy people capable of per
forming marvellous journeys without partakin
of food, or on the most meagre fare. The
have no surplus flesh about them. In thi

y have at least the advantage of the
jority of Europeans.

reen tea has never been manufactured
Darjeeling beyond an experiment. The
cess is less varied than that just described
black, but here I cannot speak from ex-
ience. Mr. Fortune, who travelled in China
m 1848 to 1851, was the first to place beyond
bt that both kinds of tea are made from
same shrub. The Indian planters were
, I believe, successful in producing tea of
deep or uniform a green as the Chinese,
ause they did not resort to artificial colour-
with Prussian blue, gypsum, &c.

Brick tea claims to be mentioned. It is
gely used in Tibet and the adjacent coun-
es, on the direct route to which Darjeeling is
uated, but the trade has so far been exclusively
th China. The possibilities of trade in this
ection have never altogether been lost
ht of. A few bricks have occasionally
en prepared by way of experiment. At
esent all that can possibly be done is to
certain the requirements of the market, as
our recent treaty with China British-grown
cannot be imported into Tibet before 1st
ay, 1899, and then "at a rate of duty not
ceeding that at which Chinese tea is im-
rted into England."

Much might be said on the all-important
bject of quality. In Darjeeling that depends
ainly (1) upon soil, on (2) the vigour of the
shes, (3) variety of plant, (4) elevation, and
st though perhaps not least (5) the season
nd mysteriously so often), the weather.
part from these natural advantages or dis-
lvantages as the case may be, much is due
skill and unremitted vigilance and care
roughout all the operations; and an ample
pply of machinery, factory accommodation
d equipment, to enable any rush of leaf to
coped with advantageously. As explained
ltivation must tell in the long run, but for im-
ediate results fine plucking is the main point,
secure which an ample supply of labour is
dispensable. Indeed, I have always believed
at half the battle is outside the factory
tirely. It is quite easy I admit to make
ad tea out of good leaf, but it is on the
ther hand beyond the power of the most
killed to obtain quality from coarse badly-
onditioned leaf. The spring teas are now
ferior to what they could be, because the
lucking is then for the benefit of the bushes,
ot for quality. Better teas could very easily
e made at the outset, as had often been done,
t the cost of the bushes; and though not of the quantity in the same year certainly at the expense of the quality of the after flushes. Contrary to general belief, I am fully convinced that the maximum crop the bushes can safely yield is quite compatible with the best quality. This is merely a question of labour.

From the illustrations already shown, it must be evident that one of the great advantages of Brirish grown tea is the cleanliness of its preparation compared with the unsavoury methods of hand and feet manipulation still common in China, and not pleasant to think of, considering the climate and the habits of Oriental labourers. The contrasts, as described and illustrated by Mr. Fortune, furnish matter for a separate paper.

The important subject of the chemistry of tea I am not able to deal with scientifically, even if time permitted. In spite of the able and valuable efforts of Mr. Kelway Bamber and others, I fear practice has as yet benefited little, and this remains practically an unexplored field of investigation.

Some of the earliest Darjeeling gardens were planted in part with a good variety of hybrid, which still influences the quality of their produce. Afterwards, for a time, there seemed a reaction in favour of the China plant, but for the last 15 years extensions generally have been with hybrid. It would not be well to plant pure Assam or a high-class hybrid solely, as that would fail to yield the true Darjeeling flavour. The Assam indigenous has also a tendency to become deciduous on the hills, if not upon the choicest sites. A blend from China and hybrid plants is, I believe, best of all, and I may say that all Darjeeling gardens, famous for quality, have this. I have experimented with small fields of Assam and Munipuri indigenous, and have always recommended extensions with hybrid of variety to suit the different elevations and other conditions, and would do so still, because, in addition to other advantages, leaf is gathered from such more economically. There are, however, many slightly different shades of variety of the China plant. During the struggling days of tea, 30 years ago, it used to strike me that much alone would have been gained by planting only a careful selection of the best strains, capable of still further improvement by cultivation; and I am fully convinced that —especially on high elevations—the best varieties of the now too-much-despised China plant, or a hybrid nearly allied to it, will yield tea of the choicest quality. In Darjeeling plants grown from high-class hybrid, or pure indigenous seed, in course of years revert towards—or, more correctly, assimilate—the China type; and further plants which, when young, appeared perfectly uniform in variety, size, and shade of leaf, as they get older become mixed and unequal in those respects. This, as well as the fact that tea has never been found indigenous anywhere in China, would go to show that India is the original home of the tea plant; that there is but one variety, the Indian; and that the comparatively dwarfed growth and diminished leaves of the China variety are due to the unfavourable conditions of soil, climate, and treatment for centuries.

It is unnecessary to state that a tea garden is not reaped and re-planted annually; on the contrary, a tea estate is an investment from which a proprietor, after the expenditure of much capital, has to wait long and patiently for any return from its working. Even under a combination of favourable conditions one would be sanguine to expect tea to be self-supporting within six years on the hills, or from four on the Terai. But there are many contingencies, such as scarcity of labour, sickness, unfavourable weather, pests, and last, though not least, depressed markets, to upset what would seem the most moderate and reasonable expectations. Any one opening out a new garden gradually—which, in most circumstances, is the only way to do so efficiently—might certainly be considered over sanguine if he calculated upon a clear profit on its working within seven years on the hills or five in the plains. There is, however, this set-off, that with judicious and skilful treatment, the same bushes, with partial renewals, where vacancies arise, should go on yielding full crops for a period to which it would be difficult to assign any limit—possibly not less than 100 years on good soil on the higher elevations on the Darjeeling hills. With injudicious cultivation and treatment, and upon poor, dry soil, it is, of course, different. It is, therefore, difficult indeed for proprietors and auditors to determine what to write off annually for the ageing and depreciation of the bushes. But investors in well-equipped concerns have, in these days of general agricultural depression, landed security of really the very safest class, from the fact of the tea harvest being spread over eight months annually. This secures the crop against the vicissitudes of seasons, in the form of a month or even two of adverse weather at any stage, which is certainly not the case in this country, where the whole cr comes to maturity or ripens in a few days even weeks.

On the hills labour may be said to be sol Nepalese, and in the Terai, Nepalese a and Nagpuri. It is "free," that is, not su ject to the regulation of any special legislat enactment. The Nepalis immigrate free and very many are born and bred on the t gardens. They belong to the same race the Goorkha soldier, the flower of our nati Indian army, are a capable, cheerful peop of whom much can be made. Those bred high elevations are stronger and more capa than than those reared at low, hot elevatio but the former generally prefer to remain up similar zones to those they have been acclim tised to. No class can perform so much wo at low as at high elevations. The rate wages in Darjeeling, as in all the large t districts, is high compared with that els where in India, except in connection wi European enterprises. But in addition money wages, houses, fuel, water, medic attendance and medicine, and a covering f protection from the rain when at work or on journey are provided at the expense of th garden, and most of the coolies keep goat fowls, pigs, and the headmen even have o or more cows, and occasionally a pony. I some instances land is also allowed for cult vation, which has always attractions, but thi as a rule, benefits the headmen rather than th labourer for whom it is intended, and is carrie out at a cost to the concern in land occupie and impoverished, and destruction of forest tha would seem rarely realised or even thought o Though the wages may not seem high generally 5 rupees 8 annas to 6 rupees 8 anna a month for men, 4 rupees 8 annas for wome and strong boys, and 3 rupees for chil dren, for the reasons just mentioned, neces saries being cheap, and several members o the same household working, those coolie who work full time or nearly—which very man will not do—contrive to save a considerabl proportion of their earnings. At market an on holidays the garden labourers dres brightly, and their savings are conspicuous i the form of strings of rupees or other coin around their necks, and the costly gold an silver ornaments worn. Native assistants, contractors, overseers, artisans, engine-drivers, machine attendants, teamen, and petty gangers earn very high wages for the East, and the coolie class have often the opportunity of adding to their monthly wages by extra sks performed—contracts undertaken, and e like. Within the last 25 years much as been done for the coolies' comfort and elfare, and as their tastes expand more ill be done. From a somewhat intimate nowledge of both classes I, without hesitaon, assert that, considering the nature of the ork and climate, those coolies in their own phere are at least as comfortable as the agriultural labourer at home was thirty years go, and certainly more contented than he is ow. The natives have many excellent opporunities of improving their position on tea ardens they otherwise could not possibly ave had. As an instance, one Nepali from nfancy known to me, whose father was a arden coolie on the ordinary pay, and who imself worked as a boy at 3 rupees for a time, nd is self-educated in English, was gradually, ut most deservedly, promoted, till for years e has been in receipt of 110 rupees a month, nd in addition bonuses on the profits as a eward for valuable services rendered, amounting to from one-third to three-fifths of his salary nnually. Numberless other instances could be given of the betterment of natives on tea gardens, to which there is no parallel in native farming or other pursuits. No one could be 30 years in Darjeeling without becoming strongly attached to the place, but I also parted from the natives with no little regret. And this much I feel in justice bound to say, that whatever little I may have been enabled to achieve in the way of modern tea extensions, under some considerable natural disadvantages, was in no small measure due to the loyal aid I have had from natives, and that among the more intelligent of those who worked with me for long periods of years I have found some absolutely truthful and honest, and not only competent but as conscientious and diligent workers as could be wished.

In regard to tea nothing is of greater importance than labour. In this respect Darjeeling is comparatively fortunate, though many gardens—especially those at low elevations or without special attractions to offer—are as a rule short of requirements not only for high but fair cultivation during the manufacturing season. One serious drawback, however, is the small and steadily diminishing proportion of men coolies upon the gardens. In the case of one concern employing not less than 1,400 coolies daily the proportion of men has fallen within the last twenty years (not to go further back) from 42·6 per cent. to 17·5 per cent. last year. This I have ascertained from the records, but before leaving Darjeeling, in 1893, I was assured by several managers, on whose authority I could fully rely, that the men upon their gardens did not average more than 5 to 8 per cent. of the labour force. This may be due in some slight measure—but only to an inappreciable extent—to the growing wants of the station and the spread of education. The evil, now most serious, may be to put down as entirely chargeable to the Government recruiting at Darjeeling for military police, and in the past for various military expeditions, public works, and other departments. I do not charge the Government officials with willingly doing this great injustice, because, on the contrary, I feel perfectly assured they would be delighted to benefit the industry and district, as, I am glad to acknowledge, we have often had proof. But yet the recruiting is not put an end to, notwithstanding the repeated appeals of local representatives of the industry. This is doubtless due to the change of governors, and the administrative head of the district only holding his appointment for two years. It simply arises in this way—the men are urgently wanted at short notice and must be got, but all the same the injustice is very great. The gardens have collected their coolies at considerable outlay, and are relying upon them for efficient working. Of those who leave on military service, many never return, and most who do are broken in health, so the injury inflicted is permanent, as statistics prove. The system is most unjust; it inflicts heavy loss on proprietors, and untold annoyance to managers, and has the worst possible effect on the coolie morally. The remedy is very simple. Let Government lay its plans sufficiently ahead; decline to entertain garden labour under any pretence; make advances and recruit from Nepal, as the planters do, or from the plains of India or their own native colonies at Kalimpong and elsewhere in the district, which, as stated, exceed the tea grants in area, and must be pronounced a great failure in every way if unable to meet such a demand. I hear that Government have recently proposed to restrict recruiting in the Darjeeling district. But this is not sufficient now that the evil has become so acute, the gardens having been so depleted of men. The recruiting at markets or other centres frequented by, and the entertaining of, garden coolies obtained directly or indirectly should, I submit, be entirely discountenanced and put an end to by Government. I most respectfully but earnestly appeal to the executive of the

Society of Arts, our Chairman, and other gentleman powerful in the councils of India, present with us this afternoon, to use their influence to aid the Darjeeling tea industry in this matter.

Another important subject, which can only be briefly mentioned, is forests. Their conservance, in the majority of cases, has been too little attended to, and proprietors must soon discover, if they have not already done so, that they have, to their own irreparable disadvantage, been playing into the hands of the Government Forest Department, the fuel-economising boiler inventor, and the electric engineer.

Neither can blights be dealt with. These are sure in time to follow large tracts of cultivation of whatever kind, and those concerned must make the best of the situation. "Red spider" commenced its ravages in the district in 1876. It was first most severe in what seemed a special zone of its own—the dry, hot valley of the Little Rungheet river; now it is pretty general in the Terai and all over the hills. Nowhere has the pest been entirely eradicated, but a very effectual remedy is sulphur, which on many soils acts also as a manure. The "mosquito blight," though noticeable 25 years ago, was nowhere severe till about eleven years ago. It has long done serious damage in the Terai and Mahanuddy Valley, and seems to have increased in severity in other parts of the hills during the last few years. Owing to this pest being winged and migratory, and its attacks worst when quality should be at its best, it is less amenable to any application than red spider; but so far as my experience goes, injures the health of the bush less. Numerous other pests are known, but none of them are, as a rule, really very hurtful. "Green fly" does not injure the constitution of the plants, improves quality, and proves helpful rather than otherwise. And there is this consolation, that pests on the whole, if they do not become more serious than they have yet been, may not be looked upon as altogether an unmitigated evil in these days of threatened over-production, from extensions recently and now being made, as well as in view of the cropping potentialities of the present bearing areas.

The Terai was opened out with inordinately sanguine expectations of proving much more remunerative than the hills; and at present I cannot but believe it has become unduly depreciated in public estimation. This is the rule with tea. The greatest drawback is undoubtedly its unhealthiness. In this respe there has been less improvement than mig have been expected from the clearances. A has been remarked, it has also suffere severely from blights. The soil is general good, though not equal to the best of th Dooars, with which, however, it compar much less favourably in regard to spring rai fall. The Terai has suffered from its labo having been attracted to the Dooars, an when attacked by blights, and requiring a the more liberal cultivation, I cannot but thin that for some years before 1893 (when I la visited it) the short-sighted policy has bee but too often that of restriction and starvation If this continues, the gardens cannot fail t fall more and more into the hands of nativ managers and owners. Under an improve water supply and sanitation this distric should become more salubrious, and, wit liberal and suitable cultivation, and efficient but economical management, the Terai shoul yet compete, not unsuccessfully, with mos other districts.

Interesting though it be, the subject of a tea planter's life, duties, qualifications—which are multifarious—and prospects cannot be entered upon here. One observation I may be permitted to make. On tea gardens al Europeans, in relation to age and socia standing, have the welfare, happiness, and comfort of numerous fellow creatures in their hands, to an extent unparalled in this country. Hence their responsibility and influence are proportionately great. Those, therefore, who are unswervingly just in their dealings with, and have a kindly fellow-feeling for, the natives—a knowledge, not only of their language, but of the little idiosyncrasies of mind and thought, and are most considerate in regard to their customs and habits—will best discharge their duty to a subject-race, and cannot fail to prove the most successful planters. Very much depends, of course, upon the European staff. Their lives, as a rule, are retired and solitary, often wanting in plain comforts. Their duties are exhaustive, and frequently depressing, and, when faithfully discharged, they should meet with the support, encouragement and sympathy of the proprietors and directors.

What has, more than anything, enabled the industry to cope with the greatly diminished sterling price of tea during the last twenty years has been the introduction of labour-saving machinery and the fall in exchange.

The most encouraging out-look for the

ture of the British-grown tea industry that 38,428,157 lbs. were taken by marets outside the United Kingdom during 395, being an increase of 9,000,000 over 1894, s against 19,300,000 in 1893, and nearly ree times as much as that of 1890, which as 13,400,000 lbs. There is, therefore, every eason to hope that under energetic and well-irected efforts to develop them the foreign arkets will absorb—or go very far to absorb—e greatly increased crops to be expected om the large extensions recently made, and till being made. The expected reduction of nports from China for 1896 is also enouraging.

But the fact must not be overlooked, that only hrice within the last thirty years have we found he consumption of Chinese tea increase and hat of Indian fall off in the same year, as has een the case during 1895. Though there are ome, directly in touch with the consumer, who assert that there is a reaction setting in n favour of Chinese tea, I believe the slight elapse is quite satisfactorily explained otherwise, and may be ascribed to medium Indian eas having been comparatively dear for a few nonths early in the year. Still the public aste in tea cannot, more than in anything else, be entirely exempt from the law of the pendulum. We are apt enough to console ourselves that the home market has been won. Be it so, we have got to hold it. We may also have new competitors, such as Japan, to ay our account with. It, therefore, behoves all concerned to see well to the weak points in our methods, and leave nothing undone that is needful to insure the supremacy of British-grown tea in the public estimation at home and abroad.

One matter I feel in duty called upon to allude to in this connection. I refer to the handling of our tea in the London warehouses. This is perhaps not the place for free criticism or full discussion. I shall not, therefore, enlarge upon the cruel manner in which the lids of the chests are removed, and the lead linings opened; or the exposure of the tea for a greater time than it ought to be in bulking; the condition in which the linings are replaced, especially those which have accidently been in contact with a nail; the refilling under the heel of the dock labourer; and, worst of all, the boxes being left unsoldered till they reach the consumer in the country, or it may be America. I have every sympathy with the warehouses in regard to the pressure upon them through the work being crowded into so short a time. But no one can say the teas are treated as they ought to be. No natural atmosphere is absolutely dry, and that of London is often very damp, and tea is extremely absorbent of moisture or any taint in the air. The papers carefully placed under the diminished and tattered lead linings are necessary to prevent the contents from pouring out in transit, but are altogether inadequate for the exclusion of damp from a substance so attractive of moisture and so volatile of its aroma as tea. The tea cannot fail greatly to deteriorate under the treatment the Indian produce generally undergoes. The system also of dealing with the fractions of pounds in weighing the gross and tares, telling in both directions against the producer, is manifestly unfair. The difficulty of interfering with long-established trade customs must be admitted, and I am saying nothing here against the 1 lb. draft, which is a known quantity, and surely ought alone to be a liberal trade allowance. Though the loss in taring may be averaged and allowed for over large operations by the buyer, it must partake of the nature of a lottery, and is most unsatisfactory and objectionable to the producer, especially the smaller of them, who keenly feel it to be an injustice. Though the Customs by general order provide for tea being weighed net, which would mitigate the hardship, and as far as I can see, also overcome the difficulty of uneven tares, strange to say the concession remains a dead-letter. The remedy for the evils complained of seem simple:—(1) Bulk at the factories, with tares equalised for each break; (2) repack dry at once, with the packing machine, the small proportion of chests it would then be compulsory to open on this side, repairing the linings with lead, resoldering or otherwise hermetically sealing the contents as may obviate the use of fires if need be; and (3) weigh gross and net (not the tares) under the general order referred to, amended if necessary to meet all reasonable requirements. It is satisfactory that at least in one warehouse (St. Olave's) packing machines have been fitted up to supersede the trampling process, and this laudable arrangement merits recognition and encouragement by importers.

In this great metropolis it might be expected that the methods for dealing with such an important article of food would be intelligent, cleanly, and even scientific. The prevailing practice is but too much the reverse of all this. The usages, to put it mildly, are antiquated and unworthy of a great industry. It is indeed amazing that they have been tolerated so long. They are productive of most serious loss to the producer and consumer as well as a loss to the national exchequer; must be an annoyance to the brokers and dealers, and disadvantageous to even the warehouses in the long ru More than this, they are grievously fetteri and handicapping the British tea industr The time is certainly ripe for combined acti to secure the urgently-needed reforms, whi if delayed cannot fail, sooner or later, to inju this great distributing tea centre.

APPENDIX I.

Table Compiled by Mr. A. G. Stanton, Showing Gradual Displacement of China T since 1866, with per-centage of each kind used, and Quality of all Tea per Head o Population.

Year.	China, &c.	Per cent.	Indian.	Per cent.	Ceylon.	Per cent.	Total.	Quantity per head o population in lbs.
1866 ..	97,681,000	96	4,584,000	4	—	—	102,265,000	3·42
1867 ..	104,682,000	94	6,360,000	6	—	—	110,988,000	3·68
1868 ..	99,339,000	93	7,746,000	7	—	—	106,815,000	3·52
1869 ..	101,080,000	90	10,716,000	10	—	—	111,796,000	3·63
1870 ..	104,051,000	89	13,500,000	11	—	—	117,551,000	3·81
1871 ..	109,445,000	89	13,956,000	11	—	—	123,401,000	3·92
1872 ..	111,005,000	87	16,656,000	13	—	—	127,661,000	4·01
1873 ..	111,665,000	85	20,216,000	15	—	—	131,881,000	4·11
1874 ..	118,751,000	87	18,528,000	13	—	—	137,279,000	4·22
1875 ..	122,107,000	84	23,220,000	16	—	—	145,327,000	4·43
1876 ..	123,364,000	83	25,740,000	17	—	—	149,104,000	4·49
1877 ..	123,300,000	82	27,814,000	18	—	—	151,114,000	4·50
1878 ..	120,652,000	77	36,744,000	23	—	—	157,396,000	4·64
1879 ..	126,340,000	78	34,092,000	22	—	—	160,432,000	4·68
1880 ..	114,485,000	72	43,836,000	28	—	—	158,321,000	4·57
1881 ..	111,715,000	70	48,336,000	30	—	—	160,051,000	4·58
1882 ..	114,462,000	69	50,496,000	31	—	—	164,958,000	4·69
1883 ..	111,780,000	66	58,000,000	33	1,000,000	1	170,780,000	4·82
1884 ..	110,843,000	63	62,217,000	36	2,000,000	1	175,060,000	4·90
1885 ..	113,514,000	62	65,678,000	37	3,217,000	1	182,409,000	5·06
1886 ..	104,226,000	59	68,420,000	38	6,245,000	3	178,891,000	4·92
1887 ..	90,508,000	49	83,112,000	45	9,941,000	6	183,561,000	5·02
1888 ..	80,653,000	43	86,210,000	47	18,553,000	10	185,416,000	5·03
1889 ..	61,100,000	33	96,000,000	52	28,500,000	15	185,600,000	4·99
1890 ..	57,530,337	30	101,961,686	52	34,516,469	18	194,008,492	5·17
1891 ..	52,287,304	26	98,941,931	49	51,227,602	25	202,456,837	5·39
1892 ..	34,483,408	17	109,528,169	53	63,102,127	30	207,113,704	5·43
1893 ..	35,735,722	17	108,143,602	52	64,218,061	31	208,097,385	5·41
1894 ..	25,805,313	12	116,965,653	55	71,570,078	33	214,341,044	5·53
1895 ..	31,433,014	14	116,343,316	53	74,023,810	33	221,800,140	5·57

APPENDIX II.

RAINFALL ON THE LEBONG TEA COMPANY'S ESTATES, DARJEELING, FOR 21 YEARS.

Years.	Badamtam Factory. Elevation, 3,330 feet.		Barnesbeg Factory. Elevation, 3,200 feet.		Mumfick, Tukvar. Elevation, 5,200 feet.		Vah, Tukvar. Elevation, 3,700 feet.	
	Days with rain.	Inches.	Days with rain.	Inches.	Days with rain.	Inches.	Days with rain.	Inches.
1872......	129	85·46	..	..	159	90·62	125	91·81
1873......	121	56·53	..	..	125	76·16	126	71·29
1874......	139	86·62	..	..	167	122·26	160	97·05
1875......	117	66·02	..	..	149	96·02	141	70·05
1876......	129	63·37	..	..	159	90·38	140	75·24
1877......	151	59·00	..	..	174	94·92	146	76·27
1878......	143	67·56	..	..	173	104·20	150	79·75
1879......	148	92·44	141	95·48	145	132·76	152	104·51
1880......	165	85·04	148	81·10	172	128·68	182	91·93
1881......	146	76·45	154	75·21	163	110·37	168	84·73
1882......	155	83·84	144	87·98	152	117·35	166	101·60
1883......	125	74·31	114	78·89	133	106·22	141	99·31
1884......	136	55·12	133	57·33	135	84·75	152	70·70
1885......	155	75·21	138	81·72	152	110·60	156	90·74
1886......	136	65·12	127	75·04	151	108·45	143	83·67
1887......	151	81·39	140	84·15	166	109·29	158	90·38
1888......	145	55·31	119	61·59	156	82·93	156	69·19
1889......	147	84·64	138	91·18	158	110·91	151	102·63
1890......	139	111·91	144	109·92	156	138·29	151	124·67
1891......	123	53·06	133	61·96	144	85·22	127	71·72
1892......	129	83·83	154	86·05	154	107·67	151	93·77

APPENDIX III.

RAINFALL AT TUKVAR, LEBONG TEA COMPANY, DARJEELING, ELEVATION 4,500 FEET, FOR THE FIVE WETTEST AND FIVE DRIEST DRY SEASONS DURING THE 27 YEARS FROM 1866 TO 1892.

Months.	WETTEST.										DRIEST.									
	1870-71.		1874-75.		1876-77.		1866-67.		1882-83.		1875-76.		1873-74.		1883-84.		1878-79.		1877-78.	
	Number of days on which rain fell.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.
October ..	15	11·13	13	13·08	14	5·19	7	10·44	13	11·29	5	0·40	..	..	2	0·22	6	3·11	4	0·78
November .	5	2·49	..	..	2	0·51	1	0·04	3	0·38	..	..	..	..	1	0·02	1	0·03	..	..
December .	1	0·07	1	0·30	2	0·74	1	0·21	1	0·03	1	0·22	..	..	1	0·08	..	..	2	0·67
January ..	1	0·03	5	1·16	6	3·21	1	0·20	3	2·99	5	0·53	2	0·32	3	0·09	1	0·01	2	0·33
February..	10	1·24	2	0·27	3	0·74	[illegible]	1·42	2	0·38	..	..	5	0·75	8	1·32	2	0·23	6	0·59
March	9	1·82	5	0·71	8	1·71	15	1·61	1	0·15	3	0·28	7	0·63	4	0·49	1	0·13	8	1·71
April	14	2·85	12	2·13	18	5·49	17	3·56	7	1·60	6	2·02	10	1·76	12	2·22	4	1·06	12	2·34
Total..	55	19·63	38	17·65	53	17·59	45	17·48	30	16·82	20	3·45	24	3·46	31	4·44	15	4·57	34	42

APPENDIX IV.

AREA OF BRITISH-GROWN TEA, ACCORDING TO GOVERNMENT RETURNS FOR 1894.

	Acres.	
India—		
Assam	154,284	
Cachar	59,586	
Sylhet	54,926	
Darjeeling	*70,038	
Julpaiguri (Dooars)	*43,133	
Chittagong	4,501	
Hazaribagh and Lohardaga	3,349	
Kumaon	3,140	
Dehra Dun	4,512	
Kangra Valley	8,826	
Madras (Neilgherries, &c.)	6,102	
Travancore and Cochin	9,079	
Burma	880	
Andaman Islands	650	
		423,006
Ceylon (for 1895)		304,843
Natal		2,297
Fiji		410
Straits Settlements (area not known at Colonial-office "believed to be inconsiderable") retained under cultivation, say		200
Total		730,756

DISCUSSION.

The CHAIRMAN said they had heard about as good a paper as could possibly be given on this important subject, a paper abounding not only in very accurate description and practical knowledge, but also illustrated in a very elaborate manner. The important part of the address—apart from the labour question — lay, not so much in the preparation of the ground for the tea plants as in the preparation of the tea. Of course, all that had been said as to forests, buildings, and the like, was very interesting, but that one could imagine; and, no doubt, in these respects their rivals in China could show quite as good a case as India. He ventured to suggest to the British public that the real hope was in the preparation of the tea. In that respect they had the advantage, and that was the reason why they were rapidly gaining ground over China. Many could, no doubt, remember when the tea industry in India was in a very low state; but now, owing to the adoption of scientific processes, that condition of things had been considerably altered. It was the possession of superior machinery which had given India the advantage over China. He should be glad to know the exact number of acres under cultivation in the Darjeeli district, and what quantity was still available for t purpose. It had been said that tea planting w almost the only industry in Darjeeling; but could recollect the time when the cultivation cinchona was an important industry.

Sir STEUART COLVIN BAYLEY, K.C.S.I., thoug they owed a debt of gratitude to Mr. Christison his very interesting and instructive paper. The pa dealt with the tea-planting industry, as a whole, Darjeeling, and there was much in it, particularly in t technical portions, as to which tea planters whose e perience had been in other provinces would have som thing to say. He had hoped to hear from the read of the paper a little more upon the subject of labo —for instance, the method of recruitment, the avera duration of contract—that was to say, whether t labourers who come from a distance stayed any tin in one garden; whether they took an annual holid to visit their homes; or whether they stayed there f years? No one could have told us better about t Nepali labourer than Mr. Christison, for no o knew them better or did more for them. Perha there were many who had attended the annu gathering at Tukvar, which was organised by M Christison, and to which many coloured crowds cheerful, well-looking labourers from all the neig bouring gardens used to flock for the contests athletic games and other amusements, promoted b their guide, philosopher, and friend, Mr. Christiso The Nepalese labourer had probably more intelligen and industry than those of any other part of India; an among the advantages which the Darjeeling tea plante had over their neighbours in Assam—and there we many—was the fact that they drew their laboure from the neighbouring country. There was grievance even in regard to those labourers—th they were taken away from the work in the te gardens and recruited for military police in othe parts of India. This question was just beginnin to crop up when he was in India. He fancied had become more burning; but as he knew nothin of its recent developments, he would leave other to say what there was to be said about it. Hi advice to the Darjeeling tea planters would be that whatever pressure they might put upon the Govern ment to get their grievances redressed, they shoul not fall into the snare of asking for a labour law. I they did, they would no doubt find their labour pro tected against Government or other competition but they would find the price which they woul have to pay a very heavy one. The great advantag which the Darjeeling and the Dooars garden enjoyed over their Eastern rivals was the fac that they had no labour law. In Assam ther was no indigenous labour to speak of, in Uppe Assam none at all. If the tea industry was to live labourers had to be imported at very great expense from Bengal. But having gone to this expense the planters required, in the fierce competition that

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* These figures show increases from 1893 and previous years that seem much too great for Darjeeling and too little or Julpaiguri.

sted, to be protected from desertion and from the irements of other employers of labour. Hence the itracts were maintained by severe communal penal-, but if the law did this on one side it did a great il also on the other. It took under its protection general well-being of the labourer, his wages, his id, his clothing, his housing, his sanitary arrange-nts, his medical attendance, &c. These were looked er by means of inspection and minute regulation, methods which inevitable as they were for the pur-se, tended no less inevitably to a considerable amount friction. A worse result was that the labourer ien thus hedged in was such a valuable asset that planter was willing to give a very large price in per Assam, over a hundred rupees for each. But difference between this sum and the actual cost of nveying the labourers to the district was so great as leave a very large margin, and inevitably there was ierce struggle set up for this margin. "Where the case is there are the eagles gathered together," a iole horde of middlemen, contractors and their ents, licensed recruiters, unlicensed recruiters, rden sirdars, and what not, all contended for the *rpus vile* which was to yield this profit, and stematic recourse to fraudulent recruiting and en to kidnapping, became common, sufficiently mmon to be felt as a discredit to the adminis-ition, and one not easily to be put down. iis point had received very great attention from s successor (Sir Charles Elliott); and one of e last of his public acts had been to appoint a mmittee, which, representing all interests, would y to regulate and co-ordinate the various nflicting and antagonistic systems by which bour for the eastern gardens was collected, re-uited, and sent up. Any arrangement by which ese conflicting and ill-regulated interests could be ought into a decent system, under responsible anagement, so that they would work not antagoni-ically, but for the benefit of the tea planters, would an advantage not only to the planter but to the bourer and to the public. He should be glad to ar about the genesis of the committee and what s results were likely to be.

Sir **CHARLES ELLIOTT**, K.C.S.I., said the informa-on given by the reader of the paper was not only iteresting to those present, but would add a good eal to the interest taken throughout England by iose who were concerned in the tea industry—not nly with regard to the cultivation of the land and ie preparation of the tea, but in the very important uestion of the way in which the tea was treated when came to London. In reply to the Chairman's inquiry s to how far the extension of the Darjeeling district was ossible for tea cultivation, he might say that there as not much more room for extension. Almost all ie land capable of being planted with tea had been iken up. The only extension possible, with a few xceptions, especially in the Daling district, where ie area reserved for tea had not all been taken up, was the gradual slow extension which went on from year to year within the areas of the different plantations whenever labour was available for clearing and planting an additional 25 or 50 acres. But there was an enormous area capable of tea cultivation in the Dooars. The land in that district was much much more suitable for tea cultivation, as it produced a vastly larger crop, the result being that the influx of capital necessarily went into the Dooars instead of into the Darjeeling district. The Chairman had also referred to cinchona, and he might say that the Government plantation near Darjeeling was the source of the quinine supply from Upper India, but the price of bark had fallen so low that the cultivation of cinchona had been abandoned in all the gardens. He wished to express his strong agreement in what had been said by Mr. Christison as to the relations between the tea planters and the population of the district, and the great utility the tea planters were in the administration of the country. He, as well as his predecessors, had always set a high value on the assistance given by the tea planters to the administration in various forms. They were the backbone of the British Government in that district; and were the chief members of the District Board, corresponding to the county councils in England, through whom were carried out the making and repairs of roads, the establishment of schools, the improvement of sanitation—in fact, every description of work. The question of labour was a difficult one in Darjeeling, though it was not nearly so difficult there as in other parts of India. Reference had been made in the paper to the depletion of tea gardens through competition by the Government in recruiting labour for military purposes in Burma and Bengal. This recruiting had been complained of by the tea planters as drawing upon their supply of labour. But the Government had taken the greatest possible pains to prevent any such grievance arising. A transport officer had been appointed at Darjeeling with a depôt there, and he had strict injunctions to see that none of the recruiters went to the tea gardens or took anyone employed there. The recruits were kept at the depôt for some considerable time; so that any planter who had suspicion that his labourers had been carried off might go to the depôt and see the recruits, and in case he identified any of his coolies the authorities would not retain them. He had heard the same story about the want of male labourers on some of the gardens, but well-managed gardens in a favourable situation did not suffer in this way. The two Tukvar gardens, including the one over which Mr. Christison presided, were instances of what could be done by good management. They did not recruit labour; they bred more labour than they could employ. The labourers lived upon these estates permanently; children grew up there and multiplied to such an extent that one of the chief difficulties was to find employment in the gardens for the children bred on the estates. In other gardens which were not so near civilisation, and perhaps not so well managed, the difficulty of finding labour was no doubt greater. The grievance was not, as might be supposed, that Government recruited coolies employed upon the gardens, but that Government went into the same market as the tea planters, and employed men whom the planters might have employed. The immigration from Nepal referred to by Mr. Christison was employed in three different ways—part went on to the gardens as they were extended, the greatest part went on to the land, especially in independent Sikkim, where agricultural extension had been very large; and a small portion was recruited by the Government for military and transport service. All that could be done was to try and arrange that the competition should not be an unfair one. The Government required very severe work from the men it recruited for the military police and for transport work. They were sent long distances, and to unhealthy districts; on the other hand, they were seldom required for a long period, whereas tea planters employed them for life. As the men had to undergo great privations while in the employ of the Government they received a larger wage than they got from the tea planter, and no doubt to the more adventurous spirits a higher wage with a short period of service was more attractive in spite of the distance and risk to life. On the other hand, the wages earned on the tea gardens were certainly large, and thrifty and diligent families were able to save a considerable sum. His own belief was that all had been done which could be done to secure fairness in the tea planter's interest. He need not say that if any well-considered complaint were made, and some grievances established, there would be the greatest readiness on the part of the Government to listen to the complaint and to remove the grievance. With regard to the wider question, which had been touched on by Sir Steuart Bayley, he might mention that the Commission which had been sitting to discuss this particular question, and the remedy to be applied, had suggested that the work of recruiting labourers for tea gardens in Assam should be concentrated into a single hand. The great evil which had arisen with regard to the competition for labourers had arisen from the immense number of different persons who were competing against each other—deceiving each other, stealing each others coolies, kidnapping women and children, or enticing them by false pretences, and even using force and wrongful confinement so that they constantly figured in the police courts. A great contrast was presented by colonial emigration, which was conducted by well-paid agents established in Calcutta, who recruit from 10,000 to 15,000 men and women every year for the colonies. These recruits were brought down to Calcutta and embarked at Calcutta at 15 rupees per head. An exactly similar class were brought down from the same parts of the country, and taken to Assam, but instead of costing 15 rupees they cost the tea planter 150 rupees. And the tea industry had to pay annually a fine of 50 lakhs of rupees on the 50,000 to 60,000 people who immigrate into Ass This large sum, or most of it, went into hands of the middlemen. The only remedy wh could be suggested was to sweep the middleman aw and he trusted this would be the result of the Com sion that was now sitting to report upon the subj

Mr. SHILLINGTON said that, having been a t taster in Mincing-lane for the last 30 years, should like to refer to one point to which Christison had alluded, namely, that of bulki It had been suggested that the dock companies not act fairly in the matter. He wished to say th although the treatment that tea received at the do was rather rough, still it was a necessity that ev parcel should be turned out and packed again. was said the remedy was to bulk the tea at gardens, but, unless they could have perfectly e quality, it was hopeless to rely on this. W regard to the question of tares, it had been said t in India they could not get wood which did not upon its way home. But this difficulty had b avoided in China, where they sawed their wood f years before it was wanted. The Indian tea indus was getting to be a large affair; and it was a terri thing to tasters to have to deal with such a la number of samples. He recollected the time wh one sample of Chinese tea would represent chests; in India a sample represented an average 28 chests, the consequence being that the tea tast had to taste some 50,000 samples each year. suggested that in future the number of packages each break should be increased to 100 chests at lea

Mr. ERNEST TYE said the paper was a m able one, and he had no doubt it would give gr pleasure to many when it appeared in the columns the *Journal*. The most important question referr to in the discussion was the labour question; but this had been so exhaustively dealt with by previo speakers, there was little left for him to say. hoped that upon some future occasion this questi would be dealt with by itself in a paper.

Mr. GEORGE WILLIAMSON said he could n agree with everything that had been said upon t labour question. Great progress had been made the cultivation of tea in India, as was apparent fro the fact that an enormous quantity was now e ported; while in 1848 (the year he entered the fiel the export amounted to only 250,000 lbs. The were large areas still suitable for tea cultivation India, but in his opinion the widening of the field consumption was a more important factor in t problem of the future prosperity of the industry th increasing the area of production. He was ve pleased to see Ceylon take the lead as an education agency, but to his mind the Ceylon tea had not t grit or body of Indian tea.

Mr. JOHN FERGUSON said that they (in Ceylo acknowledged that the Darjeeling district pr d the very finest tea, and were curious to v what increase might be looked for in Northern Southern India of finest teas. He thought reader of the paper had not quite made clear her the 10,000,000 lbs. of tea now produced in eeling from the 56,000 acres were all of the fine which sold at the highest price, and whether this age could be added to materially. Mr. Christison stated that the grants of land in private hands lled 329 square miles, and he should like to know t further portion of this could be used for tea culti- on. In Ceylon, and in the Nilgiris, the area avail- for fine teas was limited.

r. J. A. VOELCKER thought the gist of the er was to be found in the concluding remarks. at they wanted to know was what had brought an tea to the front greatly to the exclusion at from China? It had been suggested that this in a great measure owing to the advance of wledge of scientific processes and the use of roved machinery. This might be true with re- l to machinery, but upon the other point he tured to differ. His belief was that from begin- g to end both the cultivation and the manufacture ea were carried out more by "rule of thumb" n according to any scientific method. There eared to be a want of thorough knowledge of at actually did take place in the different processes. felt that the question for the future was not so ch whether here or there one could produce a fine lity of tea, or whether the area of cultivation ld be extended, but it was how large a number ld in future be able to produce the finest quality in a scientific manner. There appeared to be an ence of knowledge upon points of cultivation, for mple, as to what manure should be used and at should be avoided in order to produce the best . With regard to the manufacture, though there ht be excellent machinery, there was very little wn of the processes which were denoted by use of such chemical terms as "oxidation" l "fermentation." These terms were used in a se way without any clear idea of what they meant. til more was known on such points that progress uld not be made which was necessary to keep glish industries in India to the front. In Germany, Government encouraged greatly the development industries and the spread of knowledge concerning m, but little was done in this direction either in gland or in India. Not very long ago a Tea nters' Association in Assam decided to call in the of science to their industry, and engaged the vices of a chemist from England. But he was y given a year and a half in which to find out all out tea cultivation and tea manufacture, and soon erwards the association said they had no more ds, and his services were dispensed with. It was t in such a way as this that scientific investigation uld be carried out, and what was really needed s a patient working out of all the details, alike of cultivation and of manufacture, until the whole wa put upon a thoroughly scientific and practical basis.

Mr. CHRISTISON, in reply, said he could not contribute much to the vital question of labour f Assam, but he fully appreciated Sir Steuart Bayley advice to those districts which had no labour Act t do without one. He frankly acknowledged, and fe thankful for it, that her labour advantages were amon the strong points in favour of the Darjeeling distric, and though the grievance referred to did exist, the really had no labour question to compare with tha of Assam. Upon that wide and perplexing subje he would not venture. If, however, he might b permitted one remark, it would be, let Assam concerns recruit through a common agency, and avoi undue competition with each other; and he woul implore all districts to believe that what was for th common weal in this matter was for the best interes of individual concerns in the long run. Therefor let all pay their coolies fairly, but at stated accepte rates with other conditions for their locality, an avoid stealing a march upon each other, or ente taining, much less enticing away, a neighbour labour under any temptation or pretence whateve The question of Darjeeling labour he considered o too local a nature to be dealt with more fully than had been in his paper. Still, it was a wide and ver intricate, as well as a most important, question sufficiently studied by but few, and would alon require a series of papers to deal with it in all it phases. There were some Nepalis who had bee employed for 20 and 30 years in the gardens wit which he was long connected. Many lived and die upon the tea gardens, but they were not a long-live people more than Europeans on Darjeeling garden he grieved to say. Though, as he had said, coolie were not really under contracts to the gardens, an were free to leave at least at the close of any seaso the majority—especially women—settled down fo years. There was a considerable proportion—greate or less on different gardens—more or less shifting who came in from Nepal (a few also from Sikki and the Government farms) and returned thither in a year or two, or were induced within shorter time t leave—and these were chiefly men—for Governme service as stated, contract work, and a few from th hills (more from the Terai) for the Dooars and eve more remote tea districts. It was not unusual fo coolies, but more particularly headmen, to take leav to visit Nepal, returning to their duties on the gardens, and many visited their homes to recrui coolies at the same time. He hoped Sir Charle Elliott would pardon his differing from him i regard to some minor details. He was the mor reluctant to do so knowing Sir Charles Elliott' great ability, and that there never was a more conscientious and painstaking Governor, or one mor desirous to be fair to every industry and enterprise. He had said, with reference to Darjeeling, tha Government recruited in the same market as the te planter did, but he (Mr. Christison) begged most respectfully to submit that that was just what was not done. The planter recruited his labour, at some expense and risk, from Nepal; Government within the districts in the bazaars and markets frequented by the garden coolies. He had suggested that Government ought to recruit for the military police and expeditions direct from Nepal, as was done now for the Goorkha Regiments, as he presumed under treaty with that State, or, failing that, elsewhere in India, or from the vast native Government colonies within the district. He was fully satisfied of the anxiety of the Lieutenant-Governors and the district officials not to take garden labour, and to return any that had been taken; but it was difficult for them to obtain accurate information on all points, and recruiters, and especially petty recruiters, had their own reputation for zeal to maintain. He could give many instances of how the well-intentioned rules for the return of coolies were frustrated, by coolies being returned at the depôt at Darjeeling, merely to rejoin the recruits a station or two down the railway line and the like, only fully understood by those possessing a perfect knowledge of these adventurous hill-tribes. The experience of the two concerns mentioned by Sir Charles Elliott really proved the depletion of men referred to. In one instance the proportion of men fell from 42·6 per cent. to 17½ per cent., and in the other so straightened was the Tukvar Co. for men coolies, that it was actually forced to increase their wages by twenty per cent. He was in accord with the views expressed by Dr. Voelcker, as to there being as yet little known of the chemistry of tea manufacture. For instance, what was really known as to the action of light in withering? or the chemical changes that took place in the various stages of the so-called "oxidation" and other processes described? It was regrettable that Mr. Bamber's services were not continued. That gentleman displayed much industry, and no ordinary powers of observation, and accomplished a great deal in a short time. Mr. Bamber had only time to visit two out of the many Indian tea districts. Still, he made a valuable and most comprehensive contribution to the literature of tea, which, as far as he was aware, was the standard work on the chemistry of manufacture, if not of the entire subject at the present time. It was difficult often to get science and practice to go hand in hand. The Indian Tea Association, aided by Government, ought, as recommended by Dr. Voelcker, to employ a competent agriculturist as chemist to continue the investigations in conjunction with practical planters, and not for one or two years only, but for 20 years. In reply to Mr. Ferguson, the proportions of the Darjeeling tea crop from the hills was a little short of eight millions, and the majority of that was of true Darjeeling flavour. As stated in his paper he (Mr. Christison) agreed with Sir Charles Elliott that Darjeeling might be looked upon as a closed district for tea, there being practically but little more land available. He had no hesitation in saying that the land allotted for tea grants in Daling district was, taken all in all, the most p cipitous and barren of any hill land he had seen. course in the district there was land of gentle slop which afforded scope for as much tea as was on original hill district, and in this original hill dist there was also much land suitable for tea likewis the possession of the natives. Could this have b thrown open for tea it would have been applied for account of the more healthy situation, even m eagerly than the Dooars, but it was not desirable would it be fair to grant land there for tea now t it had been settled upon natives, besides the land been tortured, impoverished, and bared of for and would require to be allowed to lie fallow many years before it would be suitable for growing t

On the motion of the CHAIRMAN, a hearty vote thanks was accorded to the reader of the paper.

MEETINGS FOR THE ENSUING WEE

MVNDAY, JUNE 15 ... Geographical, University of Lonc Burlington-gardens, W., 2½ p.m. Annual Meetir
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.
TUESDAY, JUNE 16...Statistical, Royal United Service In tution, Whitehall, S.W., 5 p.m. Mr. Rich Price-Williams, "Railway Rates and Termi Charges."
Photographic, 12, Hanover-square, W., 8 p Mr. E. Sanger-Shepherd, "Collodio-Bromide Transparencies for Photogravure"
Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. Austin, "Zoological Journey up the Amazon 2. Mr. P. Chalmers Mitchell, "Anatomy of Hoatzin (*Opisthocomus cristatus*)." 3. Mr. G. Boulenger, "The Occurrence of *Tomisto schlegelii* in the Malay Peninsula." 4. Mr. Schaus, "Notes on Walker's American Types Lepidoptera at Oxford."
WEDNESDAY, JUNE 17 ... SOCIETY OF ARTS, 9 p Annual Conversazione at the South Kensingt Museum, S.W.
Meteorological, 25, Great George-street, S. 7½ p.m. 1. Mr. Henry Harries, "Arctic Hail a Thunderstorms." 2. Mr. J. E. Cullum, "Clim tology of Valencia Island, Co. Kerry."
Microscopical, 20, Hanover-square, W., 8 p.m.
THURSDAY, JUNE 18...Royal, Burlington-house, 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. T. Bridge, "The Intermuscular Bones of Fishes." Prof. MacDougal, "The Relation of the Grow of Foliage-leaves to the Chlorophyll-function 3. Dr. A. R. Wallace, "The Value of Speci Characters." 4. Mr. W. F. Kirby, "Descriptio of Some New Species of *Forficulidæ*, in the colle tion of the British Museum." 5. Prof. G. Allman, "The Epiphragm of Helix aspera."
Chemical, Burlington-house, W., 8 p.m.
Society for the Encouragement of Fine Arts, 8 p. Conversazione at the Galleries of the Royal I stitute of Painters in Water Colours, Piccadilly.
Historical, 20, Hanover-square, W., 8½ p.m.
Numismatic, 22, Albemarle-street, W., 7 p.m. Annu Meeting.
FRIDAY, JUNE 19... Royal Institution, Albemarle-street, W 8 p.m., Weekly Meeting. 9 p.m. Mr. Thomas Martin, "The Utilisation of Niagara."
Queckett Microscopical Club, 20, Hanover-squar W.C., 8 p.m.

Journal of the Society of Arts.

No. 2,274. Vol. XLIV.

FRIDAY, JUNE 19, 1896.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1896.

Dr.

	£	s.	d.	£	s.	d.
Cash in hands of Messrs. Coutts and Co., 31st May, 1895	1,481	6	0			
Do. in hands of Secretary	26	6	7			
				1,507	12	7
Subscriptions	5,212	14	6			
Life compositions	336	0	0			
				5,548	14	6
Dividends and Interest				554	18	3
Ground Rents				605	14	11
Examination Fees and Programmes				993	7	7
Donations to Examination Prize Fund:—						
Clothworkers' Company	30	0	0			
Leathersellers' Company	5	5	0			
				35	5	0
Conversazione, 1895 (sale of tickets)				79	7	6
Advertisements				614	3	11
Sales, &c.:—						
Cantor Lectures	19	8	2			
Fees for use of meeting-room	60	18	0			
Journal	145	5	7			
Transactions	1	10	0			
Jury Reports, 1862	1	1	0			
				228	2	9
				£10,167	7	0

Cr.

	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	409	12	0			
Insurance, Gas, Coal, House expenses and charges incidental to meetings	231	5	0			
Repairs and Alterations	46	17	1			
				687	14	1
,, Office:—						
Salaries and Wages	2,118	5	4			
Stationery, Office Printing and Lithography	290	5	1			
Advertising	95	9	6			
Postage Stamps, Messengers' Fares, and Parcels	220	7	2			
				2,724	7	1
,, Library, Bookbinding, &c.				63	16	10
,, Conversazione (1895)				448	10	0
,, *Journal*, including Printing and Publishing				2,226	2	4
,, Advertisements (Agents and Printing)				404	14	7
,, Examinations				918	5	0
,, Medals:—						
Albert	21	5	6			
Society's	34	8	0			
				55	13	6
,, Owen Jones Prizes				22	1	0
,, Photogravure Prizes				35	2	6
,, Cantor Lectures				209	0	5
,, Juvenile Lectures				20	0	0
,, Sections:—						
Applied Art	61	4	0			
Foreign and Colonial	61	4	0			
Indian	79	7	4			
				201	15	4
,, Technical Education Conference				8	14	5
,, Memorial Tablets				4	6	6
,, Committees (General Expenses)				11	6	0
,, Costs of Purchase of Ground Rents (1895)				55	0	0
,, Re-investment of Profits on Sale of Consols (for purchase of Ground Rents in 1895) in a New River Co. Share (new)				437	10	3
				8,533	19	10
,, Cash in hands of Messrs. Coutts and Co, May 31st, 1896	1,606	1	1			
Do. in hands of Secretary	27	6	1			
				1,633	7	2
				£10,167	7	0

LIABILITIES.

	£	s.	d.	£	s.	d.
To Accounts due	427	3	4			
,, Examiners' Fees	414	0	0			
,, Examination Prizes and Medals	96	5	0			
,, Examination Prize Fund	6	0	0			
,, Sections:—Applied Art, Foreign and Colonial, and Indian	190	0	0			
,, Accumulation under Trusts	510	0	10			
				1,643	9	2
Excess of Assets over Liabilities				20,769	17	5
				£22,413	6	7

ASSETS.

	£	s.	d.	£	s.
By Society's Funds invested as follows, and worth on 31st May, 1896:—					
£1,542 12s. Consols	1,696	17	2		
£500 Canada 4 per Cent. Stock	545	0	0		
£500 South Australia 4 per Cent. Stock	575	0	0		
£530 10s. 1d. New South Wales 3½ per Cent. Stock	583	11	1		
£500 New South Wales 4 per Cent. Stock	615	0	0		
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock	329	16	9		
£1,500 Queensland 4 per Cent. Bonds	1,665	0	0		
£500 Natal 4 per Cent. Stock	605	0	0		
Ground Rents (amount invested)	10,496	2	9		
New River Company Share (New)	437	10	3		
				17,548	18
,, Subscriptions of the year uncollected	424	4	0		
,, Arrears, estimated as recoverable	174	0	0		
				598	4
,, Property of the Society (Books, Pictures, &c.)				1,800	0
,, Advertisements on the Books, due, and in course of execution*				432	17
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1896				1,606	1
,, Do. on Deposit (interest on Trusts)				400	0
,, Do. in hands of Secretary				27	6
				£22,413	6

* A portion of this sum is subject to charges for printing.

INVESTMENTS, &C., STANDING IN THE NAME OF THE SOCIETY (INCLUDING TRUSTS).

	£	s.	d.
Ground Rents (amount of cash invested)	£17,669	4	0
Consols	3,146	12	3
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450	0	0
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	530	10	1
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
New River Company (New) Share (cost)	437	10	3
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

TRUST FUNDS INCLUDED IN THE ABOVE.

		£	s.	d.	
1.	Dr. Swiney's Bequest	£4,500	0	0	Invested in Ground-rents (costing £4,477 10 0), and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiene	133	6	8	,, ,, ,, of Interest as a Money Prize.
4.	North London Exhibition Trust	192	2	1	,, ,, ,, "
5.	Fothergill Trust	388	1	4	,, ,, ,, of a Medal.
6.	J. Murray, in aid of a Building Fund	54	18	0	,,
7.	Subscription to an Endowment Fund	562	2	2	,,
8.	Dr. Aldred's Bequest	173	10	0	,, chargeable with the Award of a Prize.
9.	Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10.	Dr. Cantor's Bequest	4,600	0	0	Invested in Bombay and Baroda Railway Stock (as above) and Ground-rents (costing £2,695 11 3). Interest applied to the Cantor Lectures.
11.	Owen Jones's Memorial Trust	423	0	0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
12.	Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14.	Accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

OWEN ROBERTS,
FREDERICK BRAMWELL, } *Treasurers.*

J. O. CHADWICK & SON, *Auditors.*

HENRY TRUEMAN WOOD, *Secretary.*

Society's House, Adelphi, 16th June, 1896.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One undred and Forty Second Annual General eeting for the purpose of receiving the ouncil's Report and the Treasurer's statement of receipts, payments, and expenditure ıring the past year, and also for the election officers and new members, will be held, in :cordance with the Bye-laws, on Wednesday, th June, at 4 p.m.

(By order of the Council),
HENRY TRUEMAN WOOD,
Secretary.

LORD KELVIN.

The Society having been invited to send a presentative to the celebration at Glasgow f the fiftieth year of Lord Kelvin's tenure of ıe Professorship of Natural Philosophy at the niversity of Glasgow, the Council invited Sir rederick Abel to act in that capacity, and to resent, on behalf of the Society, the following ddress :—

o THE RIGHT HONOURABLE LORD KELVIN, D.C.L., LL.D., F.R.S., &c., &c , &c.

MY LORD,—The Society for the Encouragement f Arts, Manufactures, and Commerce, of which our Lordship has long been a distinguished Member, esires to offer you its hearty congratulations on your ttainment of the fiftieth year of your tenure of the rofessorship of Natural Philosophy in the University f Glasgow.

In 1879, the Society of Arts testified its apprecia:on of your eminent services to Science, and its sense f their practical value, by awarding to you the Albert Iedal of the Society, the highest honour it has in its ower to bestow on those whose labours are devoted, ot only to the advancement of human knowledge, ut to the application of that knowledge to the puroses of daily life.

On this auspicious occasion, My Lord, you will eceive many congratulations which will remind you f the numerous and important services you have endered to scientific progress, services which have ot only made your name illustrious among your own ountrymen, but have so greatly contributed to the aintenance by this country of its high scientific osition among the nations of the world. There are, owever, few Institutions which have so good a right s the Society of Arts to lay stress on the practical alue of your scientific labours. To the science and ractice of navigation you have rendered invaluable ervice, while to your individual researches is due the ct that electrical communication from continent to ontinent is now and has long been possible; indeed, there are few among eminent workers in Science whose achievements have contributed as largely as yours to the progress of civilisation.

It is the ardent wish of your colleagues on the Council of the Society of Arts, and of all the Members of the Society, that you may long be spared to enjoy your well-deserved honours, and to continue your useful labours for the benefit of your fellow-men.

Sealed with the Seal of the Society for the Encouragement of Arts, Manufactures, and Commerce, this Twelfth day of June, 1896. L.S

(Signed)
J. F. D. DONNELLY, Major-General,
Chairman of the Council.
HENRY TRUEMAN WOOD,
Secretary of the Society.

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 17th inst., and was attended by 1,720 visitors.

The reception was held by Major-General Sir JOHN DONNELLY, K.C.B., Chairman of the Council, and the following Vice-Presidents and Members of Council :—Capt. Abney, C.B., F.R.S., Dr. W. Anderson, C.B., F.R.S., J. Wolfe Barry, C.B., F.R.S., Sir Steuart Colvin Bayley, K.C.S.I., Lord Belhaven and Stenton, Sir Frederick Bramwell, Bart., D.C.L., F.R.S., George L. Bristow, Sir George Hayter Chubb, Francis Cobb, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., W. H. Preece, C.B., F.R.S., Sir Owen Roberts, M.A., D.C.L., and Alexander Siemens.

Promenade Concerts were given by the Band of the Royal Artillery (conductor Cavaliere L. Zavertal) in the North Court, and by the Red Band (conductor, Mr. M. Poole) in the Textiles Court of the Museum.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, was given in the Lecture Theatre.

Proceedings of the Society.

◆

APPLIED ART SECTION.

Tuesday evening, May 19, 1896; Professor W. C. ROBERTS-AUSTEN, C.B., F.R.S., Vice-President of the Society, in the chair.

The paper read was—

THE ART OF BRONZE CASTING IN EUROPE.

By George Simonds.

About ten years ago, it was my privilege to deliver an address in this room on "Artistic Bronze Casting," and when I received the invitation of your Society to read another paper on the same subject, I confess that my first impulse was to avoid the task. I was afraid that I should, of necessity, go over much of the same ground that I had traversed on the former occasion, and only weary you by repetition. Besides this, I had fresh in my memory that admirable paper on "Japanese Bronze Casting," delivered some twelve months ago, when Mr. Gowland treated the whole practice and theory of bronze casting in so complete a manner that it seemed superfluous for anyone to say more on the subject, unless he could show some entirely new process, or point out some hitherto unknown principle of the art.

Now, I confess, I have no such discovery to boast of, and yet I am here. I remembered that the historic side of the question had not been touched on in my former paper, which was almost, if not entirely, confined to the technical difficulties which this art presents. I propose, therefore, to treat the technical part as concisely as may be consistent with lucidity, and I do this with an easy conscience, as many of you are familiar with the process, and there are now several bronze foundries in England where excellent work is carried out on the waste-wax system.

When Mr. Alfred Gilbert, Mr. Onslow Ford, and myself first began to agitate for the introduction of waste-wax bronze casting in this country, there was scarcely anyone in England besides ourselves who had any knowledge of the subject; nor was there any foundry on this side of the Alps where waste-wax casting was practised or understood. For years we were unable to awaken any interest in the subject, but at last I was asked by the editor of the *English Illustrated Magazine* to write an article on bronze casting, which was published in 1883. This was followed, curiously enough, for there was no pre-arrangement, on the very next day by a most interesting lecture at the Royal Academy by the late Sir Edgar Boehm, assisted by Mr. Alfred Gilbert.

In 1884, further interest in the subject was aroused by the very able and interesting report of Sir J. Savile Lumley to Earl Granville on bronze casting in Belgium, where the waste-wax process had just been experimentally int duced by the Société Anonyme des Bronzes, Brussels. In Paris also, M. Gonnon had p duced more than one work by the wax proce although it was stated, I do not know w how much truth, that these were only part successes, having need of very considera repairs and chasing before leaving t foundry.

From that time to this the interest in t process has gone on increasing; and there now no difficulty in getting bronzes cast the wax process in England. This, and t advance in sculpture that has taken place the public estimation during the last twen years, must be my excuse for again addressi you on the same subject.

As to the antiquity of bronze casting Europe, we only know that it dates from pr historic times, and that it is impossible to s how or where it originated, or to give to a individual the credit of its invention. Sir Savile Lumley says that according to sever Danish and German writers, the Europe bronze of prehistoric ages was probably indigenous industry, not of Phœnician origi but originally discovered in Britain. I a content to accept this theory as being quite worthy of belief as the legend for which Pli is responsible, that the art of bronze casti was invented by Scytes the Lydian, or The phrastus the Phrygian.

The Palafites, or lake-dwellings of Sav and Switzerland have yielded a very co siderable harvest of early European bronze and also, in some instances, they have pr served some record of the manner in whic these were produced. At Thonon, in Switze land, a mould for a spear-head was foun which was composed of two slabs of stone, o each of which a spear-head was cut out to proper depth. The two stones, being place face to face, and bound together, would for a very simple but effective close mould fro which many casts could be taken, without an injury to the mould itself. It is this mould which Sir J. S. Lumley says that a moder lance-head was produced from a prehistori mould. It is probably the earliest know example of piece-moulding amongst Europea bronze founders.

All their works, however, were not produce by piece moulding, since another mould wa found, made of clay over a wooden patter which seems to have been burned out, leaving a cavity to receive the molten bronze. In this, then, we find the first principle of the wax ocess, namely, the destruction or " wasting " the pattern by fire.

This earliest process, which we may term waste-wood process, would be only applica- e to simple forms on account of the difficulty completely destroying the wooden pattern, d afterwards getting rid of the ashes from e cavity of the mould; but it was a eat discovery, and doubtless the genius who vented it would not be long in discovering at other substances more easily wasted by e, such as wax, were capable of being shioned into various shapes, and of being vantageously used as patterns for bronze sting; and there is every reason to suppose at the more important works found amongst e lake dwellings of Lake Bourget were cast the very waste-wax process which we have en trying to revive in England for the highest ass of bronze statuary.

In the opinion of Count Casta de Beauregard, ose discoveries in Lake Bourget have so eatly enriched the museums of Aix and ambéry, these settlements were destroyed a race of men of the iron age, who carried e and sword through the district long before e Roman era. Be this as it may, there can no doubt as to the great antiquity and tistic value of the wax process, and moreover the ancient European nations do not seem have been in the habit of making piece oulds, except of the most simple description, mely, in two halves, it is not easy to see how se they could have executed large or com- icated works. It is true that clay figures of e Tanagra type were got from moulds which ere made, as I believe, in two halves, and me of these figures seem to be of a compli- ted character. Yet the heads and arms ems to have been moulded separately, and e undercutting in folds of drapery, &c., to ve been omitted. Each of these figures erefore would consist of the following sepa- te simple piece-moulds :—First, the body or unk of the figure; second, the head; third d fourth, the arms; four moulds in all. After e soft clay had been squeezed into these oulds it was an easy matter to join heads d arms to the trunk of the figure and to re- uch the whole, which was then allowed to y, after which it was fired in a kiln and be- me terra-cotta. This principle of dividing e figure into several parts to be afterwards ined up to form a complete whole was a great scovery in the art of the moulder.

Of all the European nations of remote tiquity the Etruscans and Greeks stand forth pre-eminent as artists, and when we think of antique sculpture, whether in marble or bronze, it is Greek sculpture that is always in the foreground of our thoughts. And it would be strange if this were not the case, since we possess in our museums so large an amount of works, which although they are chiefly rather from Rome than of Greece, yet the Roman sculpture being greatly an echo of the earlier Greek art, was inspired by Greek legends and traditions, and executed almost without exception by the hands of Greek artists often brought as slaves from Greece to Rome, and employed by their conquerors to reproduce the originals they had brought to Rome as the spoils of war.

In ancient Greece the art of the statuary in bronze was held in high estimation; the desire of possessing bronze statues of divinities, heroes, and statesmen seems to have been insatiable, and there were more bronze statues than we modern sculptors can conceive of.

It is then of Greek bronze casting that I propose to speak first. According to some old author — Pausanias, I believe—the art of modelling the figure, and of casting it in bronze, was first practised at Samos about 700 B.C. Many writers on art have put forward various theories as to how the old bronze statues were produced, and as many of these writers knew nothing about bronze casting, their ideas were often somewhat absurd.

Winckelmann, for instance, states that the horses of St. Mark's, at Venice—of which there are four—were all cast out of two moulds, not knowing that the mould is destroyed every time a bronze casting is made Lemot, the French sculptor, who made some repairs to these horses, when they were taken to Paris by order of Napoleon the First, had ample opportunity of examining them, and found that their heads and necks were cast separately, and that collars had been added afterwards to conceal the joints. This is not surprising. It is very doubtful if the Greeks or Romans ever attempted to make castings of the dimensions that we find to have been successfully carried out in later ages. It is pretty certain, I think, that they cut up their larger works, and cast them in parts, which were afterwards fitted together on much the same system as the terra-cotta figures were produced in clay. There is much to be said in favour of this system for large work, and little to be said against it. I will try briefly to tell you what, in my opinion, are the advantages and disadvantages.

A bronze casting, unless it be of very small size indeed, is always cast hollow, and, in order that it may be so cast, it is requisite that it should have a core inside as well as a mould outside it.

Now it is clear that if an object like a horse is to be cast, with a core inside, and if it is to be cast all in one piece, then that core will have to stay inside, since there will be no opening whereby it can be removed. Now the great weight of the core inside is a considerable disadvantage in erecting or moving a statue, and puts an unnecessary strain on the legs, which have quite enough to support without it. Moreover, the material of which cores are composed is excessively porous, taking up moisture greedily from the air, so that it is a source of danger to the thin bronze statue, which is certain not to be absolutely air and damp proof. There will be here and there some tiny fault, through which the core will absorb, and at last become so moist, that a severe frost might swell it almost to bursting. If the horse is cast without his head and neck, the core is easily removed and these dangers avoided.

There is, however, a more weighty reason for casting a horse without his neck and head. When the bronze is poured into a hollow mould it is at a temperature of, roughly speaking, 1,900°, consequently the air in the mould is expanded so suddenly that, unless escape were provided for it, an explosion would be the result; but although the main body of air escapes through the vents, there seems to be a film of air remaining, which, I imagine, prevents actual contact between the walls of the mould and the metal, so long as the latter is in motion and the mould is not yet full. When the mould is full, the outward pressure of the fluid metal forces this film of air out through the pores of the core and of the mould; those of the mould give a fairly free passage outwards, but the core cannot do so, however porous it may be, if it is enveloped on all sides by the bronze. In this case the gases that should have passed away through the core come boiling up through the fluid metal, forcing their way to the vents, which themselves full of metal, can no longer act. The gases become imprisoned in the bronze as it sets, and the result is a bad unsound casting, "blown on the core," as we say, and full of holes like a sponge. To avoid this the ancients cut their large works to pieces. The only drawback to cutting is, that unless it is skilfully done, it is impossible to join it again without altering the movemen proportion to some extent.

There are various ways of making th joints in bronze, but at present I will mer say that the ancients used to cover the joi if possible with a bracelet or a band of or ment of some kind, and joined the pa together with rivets. They also made species of box-joint by bending a strip metal round the inside of an arm, and rivetti it in such a manner as to allow a couple inches to project beyond the edge of the c metal; this projection was then forced in the corresponding edge of the part to joined, and secured in position by rivets. The joints were frequently further strengthened dowel plates of a double dove-tail form, whi were counter-sunk in the thickness of t bronze, so that one dove-tail was on each si of the joint. In principle this method is mu the same as that now in use, though practice we have somewhat improved upon The system of cutting was, I think, alwa practiced by the ancients, except in the ca of very small bronzes, such as the little Victo or Fortune, whichever she may be, and t charming statuette of Venus, both of whi are in the Naples Museum, as are also tho other highly interesting examples of bron work, which I have now the pleasure of brin ing to your recollection.

The ancients, as far as I can discover, d not understand the practice, now almost un versal, of putting a "lantern" into the cor and of core-vents. I shall speak of these lat on, merely observing at present that it possible to get very small castings qui sound, even when the core is shut in, an gives no exit whatever to the gases. Th is, however, a difficult matter, because it essential that the metal should be poured a its lowest possible temperature—that is to say it must still be quite fluid, and fill the moul easily and at once. It must also be a ver thin casting, and solidify before the heat ha penetrated the core to any distance, in whic case little or no disturbance can take place.

It is a matter of great difficulty to pour thes small castings at the proper temperature, an in many cases it will be found that they hav blown on the core from being too hot an setting too slowly, or that the metal has no been fluid enough to fill the mould properl and ensure a sharp casting.

The works of vast dimensions which wer so often executed by the ancients, of which th most generally known is the Colossus o

Rhodes, were probably not cast in very large pieces, but in sections of very considerable hickness, with flanges on the inside by which hey could be bolted or rivetted together. They could thus be built up from the ground without the elaborate internal framing which would have been needed had they been, as ome writers have supposed, made of thin wrought plates and rivetted together. Indeed, he difficulty of executing large works in beaten plate is so much greater than that of casting, that it would only be used under very pecial circumstances. It was so used by Ernest Rietschel, of Dresden, for the statue of Brunonia in a quadriga with four horses all larger than life. The reason for its use n this case being that the gateway at Brunswick, on which it was to be placed, was not considered strong enough to support the weight of cast metal. That the colossal tatue of Apollo at Rhodes was cast work, and not beaten, I think is fairly certain, since t would seem that it lay prone and in ruins for nearly 900 years, after which the metal was old to a Jew, who it is said, loaded 900 camels with his purchase. The weight of metal is aid to have been 720,000 lbs., and it seems hardly likely that sheet metal would have asted so long, or that it should not have been tolen away long before, had it not beon for he size and weight of the pieces of which it was built up. This is almost all that I can tell ou of the methods of the Grecian bronze ounders, and of the sort of work that they produced.

Of the Romans I can only say that, although hey had a passion for sculpture, they do not eem to have cared to produce for themselves hat which they could more easily acquire by onquest. We find accordingly that whenever hey wanted sculpture for any purpose they tole it from other people, and where this was not possible, owing to the non-existence of anything suitable to their purpose, they employed foreign artists in the execntion of he work. The fashion of collecting bronzes n this simple way was set, so we are told, by no less a personage than Romulus himself, who carried off from Carmerium a bronze quadriga, which he placed in the temple of Vulcan, after having had a statue of himself placed in the car. We do not know who made he statue of Romulus, but it could hardly have been by any save an Etruscan artist.

According to Plutarch, one of the Tarquins dedicated a quadriga to Jupiter Capitolinus, nd we are told that artists were brought from Veii for its execution. This seems probable, since Veii is only some 12 or 15 miles from Rome, and was an ancient and civilised city long before the days of Romulus and Remus.

As early as the days of Numa laws were made concerning sculpture, and one of these forbade the representation of the gods. But it does not seem to have been observed, since Tarquinius Priscus employed the sculptor Vulcanius, of Veii, to make a sculpture of Jupiter, which he placed in his temple on the Capitol. Another curious law of Numa's restricted the height of statues to great men. These were not to be more than 3 feet in height, and were hence known as *tripedanæ*. It is therefore to be presumed that "half life-size," as we should now call it, was the size of the statue of Horatius Cocles, which was erected in the *comitium* after his noble defence of the bridge.

For very many years, then, the Roman demand for sculpture, whether in bronze or in marble, was supplied by foreign lands and foreign hands. Indeed we are told by Perkins that the first foreign sculptor of whom any record is found was one Manurius Vitturius, who seems to have made copies in bronze of the *ancile*, or little shield which the Romans believed to have fallen from heaven; and although after that period a few names are found, still they are merely exceptions that prove the rule.

Greek artists, however, had been brought to Rome, and with them the traditions and practice of their native art. That these rapidly deteriorated amongst their new surroundings is hardly to be wondered at, since their employers and their public lacked the appreciation and the cultivation of ancient Greece. The emperors changed the fashion in art according to their own whim or love of ostentation. Caligula, says Perkins, decapitated Greek statues, and placed upon them his own vile head, while Nero gilded the masterpieces of Lysippus, and employed Zenodorus to erect a colossal statue of himself, which is estimated to have cost a sum equal to about £3,600,000 of our money. Pliny remarked that it showed how much the art of casting in bronze had deteriorated. It is hard to understand how this vast sum could have been spent on this statue, and it is a pity that we do not know more about it. It lasted, however, but a short time, having been destroyed by the people of Rome to mark their hatred of the man it represented. We have another work, however, of that period, in the equestrian bronze statue of Nero, in the museum at Naples, of which I am able to show you a photograph on the screen. I am, however, of the opinion that this statue is rather a Greek than a Roman work, although I can give no account of its history or authorship, save that it was found at Pompeii.

In strong contrast to this work is the well-known equestrian statue of Marcus Aurelius, remarkable above all else as being, I believe, the only statue of an emperor which, from the time of its erection to the present day, has always been respected and carefully preserved by the Roman people. There is, I believe, nothing known as to its authorship, and we can only guess, from a certain heaviness and from its general style, that it is probably the work of a Roman artist or, at least, of a very Romanised Greek. This, at least, is the opinion of Perkins, and I must say that it is also my own. I am quite unable to find any signs of Greek feeling in it, and although it is undoubtedly, in many respects, a noble and impressive work, yet I must certainly protest against its being considered, as it has been by some writers and many readers, to be the finest equestrian statue in the world. Winckelmann, who seems to have a natural gift for mistakes of this sort, supposes this monument to have been of beaten plate, and this story has often been repeated. It is, however, nothing of the sort, but is a waste-wax bronze casting—not, however, cast at one pouring, but in separate pieces, as I have stated was usual among the ancients.

It would be too long, and indeed foreign to our present purpose, to trace the decline of the art of the statuary in bronze through the various ages of the decline of the Roman power down to the final destruction of the last refuge of art by the siege and sack of Constantinople in the 13th century. There are, however, two bronze statues that I may mention as belonging to this period of decadence, one of which is supposed to represent either the Emperor Heraclius or Erico, King of Lombardy; it stands in the piazza of the town of Barletta. According to tradition, this statue was cast at Constantinople by a Byzantine artist named Polyphobus, about the middle of the 7th century. Perkins, however, considers it to be a genuine Italian work, and believes it to be of earlier date. I have never seen this statue myself, nor any photograph of it, but as Perkins was a most excellent judge of sculpture, he is probably correct in his estimate. The other is the well-known statue in bronze of St. Peter, in the basilica of St. Peter's at Rome. This statue is said to have been cast by order of Pope Leo I., as a than offering to the saint for his interposition a deliverance of the city of Rome from Atti The date assigned to this statue is A.D. I There is a legend that it is an antique, a was a statue of Jupiter, and that the head a hands only are of Christian origin. There however, no evidence of this, and, on the co trary, plenty of internal evidence that the wo is of one period, and that not classic. Possit an antique Jupiter may have been melt down for the sake of the metal, and as further honour to St. Peter by the destructi of a pagan divinity.

The period from the 5th to the 9th centu gives us no record of any Roman artist, a we may easily understand that the iconoclas war and wholesale destruction of statu which was so vigorously prosecuted by L the Isaurian and his son in the 8th centu must have given the *coup de grâce* to t already dying art of the statue founder; neve theless the persecution of artists, and t consequent emigration of numbers of the from Byzantium, was the means of spreadi such tradition of the art as might have su vived, into other and far distant lands, and t affiliation of numbers of these emigrants to t society or craft of the Comacine builders, w the means of bringing a knowledge of t principles of the art into France, German and possibly into England also.

During the 9th and 10th centuries sculptu seems to have been at its lowest ebb. In t 11th and 12th centuries however the art beg to receive some consideration, and artists it said were sufficiently proud of their calling begin once more to sign their works.

In the 12th century we once more find t bronze founder to the front. Borisanno Trani, Simone di Ragusa, Bonanno of Pis and Jacopo of Innsbruck, were all busy builders, carvers, and bronze founders, a cast bronze gates for several of the religio buildings of Italy and Sicily.

In the 13th century again we have the nam not only of foreign, but also I am glad to s of English artist founders; unfortunately mo of their works have been destroyed.

There are records of statuettes in bronze a also in silver by Simon of Wells, A.D. 125 and by William of Gloucester, about the sa date. A few years later, in 1281, we have t statue of Henry III., followed in 1290 by th of Eleanor of Castile, both by William Tore or Turell, who was a sculptor goldsmith and citizen of London. At the close of the 14 ntury we had Nicholas Broker and Godfrey est, who, in 1397, erected the statues of ichard II. and of Anne of Bohemia, both on e tomb in Westminster Abbey.

It is perhaps not uninstructive to note by the ection of bronzes in Westminster Abbey the ictuating fortunes of the art. Thus in the th century we have recorded the erection of works; 14th century, 12; 15th century, 10; th century, 9; 17th century, 6; 18th century, ; 19th century, 6; total, 51 works. The ove list begins with the year 1246, monuent to Abbot Berkyng, and ends in 1887, Mr. lfred Gilbert's monument to Mr. Fawcet. Of ese 51 bronzes many are no longer extant, d others are not strictly speaking bronze t are incised work, generally known as brasses."

For the present I shall only speak of the onzes by Torell, Broker, and Prest. The rlier ones, those by Torell, are most interestg works, and as examples of early English atue founding invaluable. They are cast in e piece and are enormously thick, almost lid. A few years ago, when some repairs were quired to the stonework, I had an oppornity of examining the under side, which owed a shallow depression with a rough rface. It looked as if the metal had been ured into an open mould and that some sort core heavily weighted had been pressed wn upon the molten metal so as to force it rise to the exact level of the edge of the ould, or as if whilst the metal was still fluid partially so a portion had been scooped out.

I have been much puzzled to guess how the odels for these figures were produced, and hether the wax process was employed. On e whole, I incline to the belief that the odels were carved in wood, without any dercutting, and that any necessary proctions were fashioned in wax and attached the wood models. After the completion of e mould the wax could be melted, and the ooden pattern easily withdrawn. A process this principle was used for casting cannon d bells. I am certain that these statues ere cast in one piece, and unless some modication of the wax process was used, we must nclude them to have been piece-moulded, hich I think most improbable.

The other two statues of Richard II. and of nne of Bohemia show us what progress had en made during the past century. These atues, by Broker and by Prest, were probably st in 1397. They are fine works of art and cellent castings. They are properly cored, and, although the casting is rather heavy and thick, it is not excessively so.

I have no doubt as to the process here employed. I believe the statues to have been modelled in loam, which was then dried and pared down to form a core. This was then overlaid with a suitable thickness of wax, to represent the bronze statue, and was finished to whatever degree the artist thought requisite. The whole was then moulded in loam and the wax burned out.

There is one more point to be noticed, that is, that in these statues the hands were cast separately, whereas in those by Torell they are in one piece. This may be accounted for by another reason than the difficulty of moulding, for the hands of Richard and Anne were clasped, but some thief stole them. The hands were probably added after the statues were finished and placed in position. None of these works are left from the mould, but are chased over, and richly gilt.

About a century later William Austen cast in bronze a statue of the Earl of Warwick, still extant.

A few years after Torell had completed his statues in Westminster, Andrea Pisano, one of the most noted of the Italian bronze founders, was born, and in 1330 he completed the models of his chief masterpiece, the bronze gates of the Baptistry at Florence. The casting of these works occupied him for nine years more.

It would be tedious to quote a long list of more or less able founders and their works through all the years of the Italian revival. It will be enough to mention a few of the best known amongst them, as Ghiberti, Donatello, Michael Angelo Buonarotti, John of Bologna, Benvenuto Cellini, &c.

Of Ghiberti, it is sufficient to say that he was a most famous and successful founder. The bronze gates which he made for the Baptistry at Florence are a lasting monument to his fame. Besides these, he modelled and cast the statues of St. John and St. Matthew for the church of Or San Michaele. The Baptistry gates occupied him for nearly fifty years, they were begun in 1403, and the second gate was not finished until about three years before his death in 1455. The wax process was employed for these as for all early Italian bronze work.

Donatello, born about five years later than Ghiberti, was his only rival in the bronze founders' art of that day. For the sake of brevity, I shall only mention a few of his works:—The group of "Judith and Holofernes," which stands in the Loggia dei Lanzi, at Florence; the "David with the head of Goliath," in the Museo Nazionale, at Florence, and the colossal equestrian statue of Gattamalata, at Padua. This statue which, although a very fine work, is decidedly inferior to another similar one by Verocchio, seems to have given him much trouble; it was executed between the years 1451 and 1456. At first he began to make a full-sized model of the horse in wood, but he abandoned that plan, and the incomplete wooden model is still to be seen at Padua. It is probable that the work was finally carried out in wax over a loam core, and that the casting was made in several pieces. In 1456 he returned to Florence, where he died ten years later.

The most celebrated pupil of Donatello was Andrea Verocchio, born at Florence in 1432. He executed many works, of which but few remain to us. All that he did in silver has disappeared, and we have only a few bronzes, amongst which is the charming fountain in the courtyard of the Palazzo Vecchio, and the incomparable statue of Bartolomeo Colleone, at Venice. Apart from its merit as a work of art, the history of this statue is full of interest.

The Signory of Venice do not seem to have behaved very well to Verocchio, at least in the beginning, for after bringing him to Venice to execute this statue they seem to have wished to have his pupil Vellano, of Padua, joined with him in the work. Verocchio not unreasonably considering this as a slight on the part of his employers broke up the head and legs of the horse on which he had been working and fled to Florence. On this the Signory, unable to lay hands on him, published a decree banishing him for ever from Venetian territory under pain of death. Verocchio replied that he would certainly never return, since if they were foolish enough to cut off his head they could neither put it on again nor get another as good, but that he could at any time make a new and a better head for his horse. The Venetians came to the conclusion that he was right about this, for shortly afterwards they rescinded their hasty decree and recalled Verocchio, doubling his pay, and promising that his work should in no way be interfered with. Unfortunately he did not live to complete it, and at his request the Signory entrusted his pupil, Leopardi, with the task of bringing the work to a conclusion.

It has never been known, and probably never will be known, how much of the work w finished at Verocchio's death. In his will speaks of it as *Opus equi per me principia* making no mention of the rider, from whi Perkins concludes, I think rather hastily, th he had very little to do with it except design. Had Perkins been more familiar wi the insides of sculptors' studios and foundri and above all with the colloquial Italian, would have known that nothing is more usu than for an equestrian statue to be spoken as "Il Cavallo." I have frequently heard own Italian assistants in London so speak the statue of the Duke of Wellington, althou there was certainly no doubt about the du being on the horse's back. In any case it believed that Leopardi cast the statue a made the pedestal. Verocchio began the hor in 1479 and died in 1488.

We have now reached a period in t history of European bronze casting when t art was so well understood, and so wide diffused that it is quite impossible for me present to give anything like a complete list names and to do more would require a volu which I have neither the ability nor the leisu to undertake.

Leonardo da Vinci and Michael Angelo we both engaged on works of the highest orde and although we have no bronze statue left us by the former, we have much informati concerning his great work, the equestri statue of Francisco Sforza, the sketches a notes concerning which are preserved in t Royal Library at Windsor. We know th for this work he made no less than fourte designs, and two full-sized models, the first which did not please him, and the second w never cast, for although it is beyond dou that the model was nearly if not entire finished, Leonardo was busy at the same tim with the fresco of the "Last Supper," an consequently, put off casting the statue unt it was too late. In 1499, Ludovico Sforza w overthrown, by Louis XII., who permitted h soldiers wantonly to destroy the model.

Some have thought that the bronze group "St. John and the Doctors," over the door the Baptistry at Florence, was in part at lea his work, but there seems to be but little doub that it is entirely the work of his frien Rustici.

Michael Angelo himself was also a bronz founder, and once, at least, an unfortunat one, since we find in his letters bitter com plaints of his want of success in casting th statue of Pope Julius at Bologna, which h

cribes to his having too confidently entrusted
e conduct of the process to a cannon founder
stead of attending to it himself. He
nended this error, and the second time he
st it successfully in the year 1508. Three
ars later it was destroyed by the populace,
d melted down to cast cannon.

Of this greatest of sculptors I need say no
ore, but pass on at once to the lesser men—
rregiano, born 1472, and Rovezzano, pro-
bly about the same time. Both of these
ists came to England, and were engaged,
e former on the tomb of Henry VII., and
e latter on a tomb which Cardinal Wolsey
d ordered for himself. This tomb was never
ished, and all the bronze work about it was
lted down by the Commonwealth, after the
ecution of Charles I. The sarcophagus
one was left, and was, it is said, used to
ceive the body of Lord Nelson. Consider-
ly younger than these men, having been
rn in 1500, Benvenuto Cellini, the artist,
ose name is most familiar to us all as a
onze founder, appears on the scene, and
er this time, the accumulations of experi-
ce in this art were apparently first reduced
writing; at least, I have found no earlier
atise on bronze casting than a work entitled
Pirotecnica in dieci Libri," which contains,
nongst matter, some information on casting.
was published at Venice in 1558. Besides
s, there is a most admirable little work by
llini, called "Due Trattate, &c.," published
Florence in 1568, which consists of a series
most admirably written articles on the
rious processes employed by himself in his
ofession. This work, which, strange to say,
almost unknown, is of far greater technical
lue than his autobiography, which contains
t little technical information of importance,
his Life has been through many editions,
d has been translated into many languages,
ile the "Due Trattate" was, as far as I
ow, never reprinted until 1852, when a very
or edition was published at Milan. Some
ars ago I was so fortunate as to obtain a
fect copy of the first edition, and my wife
dertook, at my request, the very difficult
rk of an English translation. This is now
ished, and I hope that before long I may
able to arrange for its publication.

About the year 1540, Cellini went to Paris,
ere he spent five years executing many
portant works in silver and one in bronze,
elievo known as "The Nymph of Fontain-
au." In the "Due Trattate" the method
casting this work is described with much
detail. The silver statues were all melted down a few years later. On his return to Florence, he was fortunate enough to receive a commission from Duke Cosimo, in 1545, to model and cast in bronze a statue of Perseus, to be placed in the Loggia dei Lanzi. This work he finished in 1548, casting it in two parts, one being the base with the body of Medusa, and the other the statue of Perseus himself. One of the feet of Perseus did not come, and was added afterwards. It is interesting to know that about 300 years later, Clemente Papi, of Florence, made a replica of this celebrated group in bronze at one single casting, which was entirely successful.

Of the other Florentine bronze founders of that period, we need only mention John of Bologna, who, in truth, was not a Florentine, but a native of Flanders, said to have been born in 1530, Perkins thinks probably some years later. Amongst other works in bronze he cast a colossal Neptune for the fountain at Bologna, and some years later the flying Mercury, the Grand Duke Cosimo in the Piazza della Signoria, and the equestrian statue in the Piazza della Annunziata, both at Florence. This last is a very inferior work, and it is believed that John of Bologna had little hand in it. It was cast by his pupil, Pietro Tacca, who probably also did most of the modelling. John of Bologna died in 1608.

The erection of equestrian statues was coming into fashion, not only in Italy, but in France and other countries. In 1604, an equestrian statue of Henri IV. was commissioned of John of Bologna, but it was not finished before the death of the artist and the assassination of the king. It was, however, finished and cast in bronze at Florence, I know not by whom, probably by Tacca, and was transported to Paris and erected on the Pont Neuf in 1616. The next equestrian statue that I have any note of is one of Louis XIII. It stood in the Place Royal, and was erected in 1639. The horse was by Daniele di Volterra, and was intended for a statue of Henri II., but the artist dying in 1556, he could not complete the figure of the king. It was afterwards utilised for the statue of Louis XIII., the figure being completed by a sculptor named Biard. I have never seen a representation of this work.

The most important casting ever made in France, or perhaps in any other country, was that of the statue of Louis XIV., by Girardon, and cast in bronze by the celebrated founder, Jean Baltazar Keller, in 1699. M. Boffrand, the eminent architect, was instructed to take notes and to make drawings of the entire process, and these form a most valuable addition to the literature of bronze casting.

I propose now to describe the method of procedure which proved entirely successful for the casting of this great work, alluding from time to time, as may be convenient, to works by other artists who may have used other means to the same end.

This statue, of which I show you lantern slide, exists no longer. It was destroyed, with many others, in the French Revolution. It was of great size, measuring 21 French feet, or about 7 metres in height. The statue was modelled in plaster, on the site where it was to be cast, in a temporary studio erected for that purpose. When the work of modelling was completed, the entire statue, horse, and rider was piece-moulded in plaster. This was not, however, an ordinary piece mould, but rather an erection of regular-shaped blocks of plaster, of such size and weight as to be easily lifted by hand. This very complicated mould was regularly built up in courses like masonry, each piece being keyed to its neighbours, until the entire statue was built in. The blocks, which were all carefully numbered and countermarked, were then removed one by one, and each lined with wax. This was first painted on with a brush, which, in my opinion, was a mistake; and when a very thin layer was thus obtained it was backed up by sheets of wax, rolled out to the required thickness, which varied according to the position, some of the parts being very thick indeed. The next point was the arrangement of the iron frame for the support of the core. This was a very complicated construction, and was all fitted together with cramps, so that it could be taken to pieces and removed, together with the core, through an opening or man-hole on the back of the horse. The irons of the legs, however, were intended to remain inside. The framework was erected above a series of flues or fireplaces, of which the use will be shown hereafter. An iron grating, which was to form the base of the waste mould, was laid over these flues, and upon this the piece-mould was erected, course by course; and the iron framing was built up, and the core was being made at the same time, so that, when the plaster mould was entirely built up and restored to its proper position, there was on the outside, first the plaster mould, next to that a lining of wax representing the bronze, and within that again the core, which enveloped the iron framing by which it was be supported.

There are many ways of making a core, they may be divided in two classes, vi beaten cores, that is to say, such as are co posed of some material that can be beaten rammed into a cavity, from which it recei the required form and cast cores, or such are poured into the cavity in a fluid state, a are then allowed to set and solidify.

Beaten cores are the safest, but cast co are the most convenient to make. In th case both kinds were used. The legs of t horse that touched the ground were to be c solid a considerable way up, and being full wax and irons needed no coring. The ta part of the neck and head of the horse, t raised legs, and the body, head, and arms the king were cast cores; but for the legs the king and the body of the horse a beat core was used, which was composed of t parts of loam and one part of horse du mixed with cow-hair and beaten well togeth with iron rods, and sufficiently moist to fairly plastic.

The workmen, passing their hands into t body of the piece mould between the irons the frame, plastered the wax shell with layer of this loam about ½ inch thick. Th was carefully dried, and other layers we added, until the lining covered in all the iro of the framing, it being then about 6 inch thick. Bricks of the same material, that h been prepared beforehand and well dried, we now used to increase the thickness, using t same loam in a more fluid state as mort until the body of the horse was fitted with sort of vault, open only at the manhole in t horse's back. In this vault braziers of cha coal were kept alight until it was perfect dry. Previously, however, the body, hea and arms of the king, as well as the rais legs, head, neck, and tail of the horse, h been cored by pouring into them a mixture one part of brickdust and two parts plaster a liquid state.

Through the body of the king three sm chimneys had been formed leading from t body of the horse to the open air above. Th is the first record I have ever found of lantern and core vents, and yet, strange say, it was not intended to be used as suc for, as the core dried, fresh layers we added, and the whole was finally filled up a solid mass—a very great mistake in m opinion.

It would be tedious to enter into every deta ncerning the construction of the core. I ve merely stated the broad fact. The next eration was the removal of the plaster ould together with the wax, so as to expose e core to view. The latter was then exam- ed to detect any cracks or other imperfections, d after these had been remedied, the lower rts of the core were further secured by a twork of iron wire, and the wax was then ece by piece replaced in position on the core, which it was secured by copper tacks, whose ads were buried in the thickness of the wax, d their points driven into the body of the re. When all the pieces of wax had been us fixed in their proper places, the next ing was to retouch the wax. This must ve been a very troublesome job, owing to e method adopted for covering the core; deed, we are told that it took M. Girardon a ole year to repair. The wax now being touched, and the entire statue being absolutely finished, the next process was the stribution of the jets, vents, and spouts or ains.

For the benefit of those who have no know- these things, I may as well say that jets, so called runners, are the pipes by which the olten bronze enters the mould and is con- cted to its remotest parts. Vents are air pes leading from the cavity of the mould to e outer air, their function is to permit a free d rapid exit to the air and gases which uld, without such exit, impede the free flow the metal, and in all probability burst the ould. The spouts, or drains as they are lled, are also pipes leading from the interior the mould to the open air. Their function to carry off the wax as fast as it is melted side the mould, as if no exit were provided would, as the heat increased, boil inside the ould, which would destroy its surface and ld a very bad casting. These pipes are erely sticks of wax of varying thickness, cording to the requirements of the case, and ey are attached to the surface of the wax odel by soldering them in place with a hot n.

There are two opposite principles employed the arrangement of jets and vents, known the ascending and the descending princi- es.

The oldest and commonest principle is the scending, which has many disadvantages, d very little to be said in its favour. It nsists in pouring the metal directly into the uld through one or many jets which dis- bute it to all parts of the mould. It enters the mould from above, and it is claimed that the mould is most quickly filled by this plan.

The other, or ascending principle, has, in my opinion, many advantages. On this principle the jets are so arranged that the metal enters the mould from its lowest point, having descended through runners, from above the head of the statue, and rises, on the principle that fluids will find their own level, forcing air, gases, and everything else in front of it, until the mould is full. This, no doubt, is the slower plan, since the metal has just twice the distance to flow, but it causes in my opinion far less disturbance inside the mould and does not necessitate so many jets and vents.

One of the bugbears of an inexperienced founder is the fear that he will not be able to get his mould filled before the metal is too cold to run or take a sharp impression, and yet, as a matter of fact, more bad castings result from too much heat than from too little. An inexperienced hand is always ready to attribute a mishap to the evolving of the metal inside the mould. Probably his mould did not fill because he had not vented it properly and an air-lock was the result, or if the casting is not sharp it is probable that he has either burned his alloy or that his mould was bad. It is not in all probability the result of casting cool.

However, MM. Girardon and Keller decided on adopting the old-fashioned descending process, and placed their jets and vents accordingly, the jets all pointing downwards and the vents upwards; the spouts of course led downwards. When all this was completed the next operation was the construction of the mould itself, together with the walls of the so-called pit, in which it was to be cast, not to forget the furnace to melt the metal.

The soil was so damp in Girardon's *atelier* that it was considered unwise to dig a pit for casting, as is the usual custom; so the plan adopted, and I believe for the first time, although it has often been done since, was to build a strong wall all round the mould and conduct the whole operation above the floor level of the studio. This wall would rise to a height of three or four feet above the top of the mould, and the mouth of the furnace would have to be a little higher than that. The furnace therefore in this case will have been about 30 feet above the ground level.

The construction of the mould was as follows:—Three parts loam of Chatillon, two parts powdered crucibles, one part horse dung. This mixture was mixed with white of egg, and ground on a stone until it was of the smoothness and consistency of oil paint, when with soft brushes a first and very thin coat was given over the entire surface of the wax, jets and vents included. When this first coat was entirely dry a second was laid on in the same manner and also allowed to dry, and so in this way 24 coats were given and dried; after this the same mixture was beaten up with cowhair and other layers added, until a thickness of about two inches had been reached. This required about 40 coats.

As the mould could no longer be trusted to support itself, a sort of net, made of hoop iron, was placed under the horse's belly and attached above to the irons that supported the core; a like bandage was put round the body of the king, and indeed wherever it seemed advisable to strengthen the mould. After this, fresh layers of loam were added to the mould, until it had received about 150 in all, and was about 8 inches thick, or rather more. After the mould had been brought to this state, it was entirely enveloped in a lattice work of bands of irons, shaped to the mould, and secured to the grating on which the latter rested. This lattice work was again covered with loam, and in the case of the legs and tail of the horse a second lattice of iron was added, and covered with loam and terra-cotta tiles, in order that it might be the better protected from the fire. The mould was now about 10 inches thick at the base, and 7 or 8 inches at the top. The next operation was melting out the wax, and firing or cooking the mould. This was a matter of very great difficulty owing to the immense size of the mould, the largest in fact of which we have any historical record. The following was the plan adopted. A kiln, which the French call *le mur de recuit*, was built of fire-brick around the mould, rising from the flues which I have already mentioned as being below the statue. This kiln was shaped as far as possible to the form of the exterior of the mould from which it was distant about 18 inches, this being considered sufficient for the fire-space. As the kiln was built up, it was filled above the flues with bricks laid in such a manner that there was a space of a couple of inches between each, and others laid above so as to form a sort of open work to allow free passage to the flames. After three courses of brick had been laid in this manner, the space between the mould and the kiln was filled up with broken pieces of brick thrown in loosely so as to leave ventilation for the fire. When the kiln had been carried above the level of the top of the mould and filled as described with broken bricks, it was covered in at the top with a layer of clay about 3 inches thick, in which, however, several small chimneys had been made without which the kiln would not have been workable.

The fire was now started in three flues on each side, and after 29 hours two more were started, and so on, with others, until they were all in work. This firing was with charcoal, and was continued for nine days and night, after which time the wax, which had begun to come away after the second day, ceased to flow. Of 5,668 lbs. of wax which were used for this statue, 2,805 lbs. were drawn, so that there remained absorbed by the mould 2,765 lbs. to be evaporated and burned off before the casting could be made.

To the charcoal fires a few billets of wo were now added, and the heat gradually rais for the space of eight days more, after whi time wood only was used, and the fi were well maintained for seven days. Th the whole of the interior of the kiln, bei at a full red heat, the flues were closed, a the mould was left to cool for eight days, af which time it was sufficiently cool to pern the kiln to be taken down.

This account gives us nine days for drawi the wax, eight days for raising the fire, a seven days more to bring the kiln and its co tents to the proper heat, and another eig days for the mould to cook after the kiln h been closed. In all 32 days, and none t much when we remember the size of t casting; and here I wish to say that firing t moulds is the one great difficulty in waste-w casting. You cannot fire too slowly. T mould and the core, to its very centre, shou be brought to a good cherry red, but no mor neither should the outside be hotter than t inside. In order to arrive at this result, gentle fire long continued is needed. A stron fierce fire only injures and destroys the mou —cracking, tearing, and warping it in eve direction; over-firing is the cause of as man if not more, failures than under-firing; and fuel is worse to use than coke, on account the great heat, and also of the sulphur it co tains. A fire of soft charcoal, or of wood, the best and safest.

The mould being now properly cooked, th next thing was to remove the kiln, and ever thing else, and clear out the pit, so that contained nothing but the mould. The spout from which the wax has been drawn were no arefully closed with loam, and the earthing-p was proceeded with. The flues, which ere directly underneath the mould, were tted up solidly with masonry, and the pit lled in with earth—thrown in to a depth of bout 6 inches, and well rammed down in very part before another layer was added; nd so on until the highest part of the mould as reached. A small quantity of plaster was fted amongst the earth thus used, in order at it might take up any dampness and pre-ent it from affecting the mould.

The next thing was the construction of the asin, or dam, to contain the metal when eleased from the furnace. This was made of n oblong shape, of beaten loam, the sides eing bricked and plastered with loam. From e mouth of the furnace a trench led with a entle fall into the dam, and from the bottom f the dam proceeded the three principal jets. he mouths of these three jets were funnel-haped, and were stoppered with carefully tted plugs at the end of long iron rods, o arranged that, by means of a lever, they ould be simultaneously withdrawn at a given ignal.

Some time previous to the completion of hese last operations the furnace was started, ith a charge of 83,752 lbs. of metal, being art old cannon, part ingots of red gun metal, art yellow brass, and about 2,000 lbs. of fine ornish tin, besides a mass of old metal that ad been used in the arsenal many years efore. The fusion of this large charge took o hours in this furnace—of which I am pleased o be able to show you some illustrations—fter which it was tapped and the entire harge allowed to flow into the dam. The lugs having been withdrawn by means of the ever, the bronze went down quite quietly into he mould, rising in all the vents up to the evel of the flooring, a sure sign of a success-ul casting. The weight of metal taken up in he statue, and its jets and vents, was about 0,000 lbs., the remainder was left in the dams. fter four days the work of digging out the it was begun, and the statue was found to be uite perfect. There only remained now to cut ff the jets and vents, and to chase over the laces where they joined the statue; also to emove the core, and, as far as possible, the ron also, through the manhole at the back and he other smaller apertures that had been pro-ided for that purpose. To close these holes, ieces had been made of wax, carefully fitted nd then removed, and placed amongst the jets n such a manner that they should be cast at the same time as the rest of the work; after which repairs, the statue only required to receive a patina, and was ready for use.

Such, then, is the history of the greatest piece of bronze casting of which we have any record in Europe, for although there are several other bronze statues that far exceed this in height, and indeed rival the colossi that were erected by the ancients, yet these were all cast in sections and fitted afterwards.

There is, I believe, no record extant of the casting of Le Sueur's fine statue of Charles I., which is a pity, for it would be very interesting to know if it is, as I suspect, a wax casting.

Chantrey, I believe, used to cast his own statues, and I have been assured that he used to cast them in piece-moulds made of plaster and brick dust in equal proportions. I know that this method has been employed by sculptors, but it is more in the nature of a makeshift than a process to be recommended, since a good loam piece-mould will be more likely to give good results.

When piece-moulding for bronze with plaster brickdust, the mould should be thicknessed up with sheets of tallow or dough rolled to the required thickness, and the core irons having been prepared and placed in position, the core, also of plaster mixed with brickdust, must be poured in and allowed to set. After this the mould must be taken to pieces, and the core removed and thoroughly dried and baked, as must also be the various pieces of the mould. They do not, however, require the same degree of heat as in the wax process. After they have been well baked they must be put together, buried in the earth, and cast as soon as possible. The jets and vents are cut in the material of the mould, in the same way as in the ordinary loam piece-moulding.

Amongst other equestrian statues cast by the wax process, I may mention Louis XV., by Bouchardon, and the celebrated statue of Peter the Great, by Falconet. This last was cast by the sculptor himself, without the aid of a professional founder, and under very great difficulties. This casting is remarkable for being, in the forepart, where lightness was most essential, perhaps the thinnest casting, for its size, in existence. In our own day many fine equestrian statues have been produced in England and elsewhere. Marochetti, I believe, was the last sculptor in England who did his own casting; but I do not know if his methods had any particular interest.

Foley's statues, such as this of General Outram, were all cast in pieces, by the usual loam process, which seems to me, when properly and skillfully carried out, to be sufficient for the purpose.

In this survey of bronze casting in Europe, I have been obliged to omit all mention of much admirable work that has been done in Germany, and in Holland and Belgium, in which last country I got my first lessons in bronze casting, in the studio and foundry of the Chevalier Louis Jèhotte, at Brussels, when I assisted him in modelling and casting the monument of Charlemagne, afterwards erected in Liège. This was entirely cut to pieces and cast by the loam process. In Italy they still, in spite of the great cost, keep to the wax process for almost all their public monuments, of whatever size; and I am pleased to show you one that was cast entirely at one pouring, about 20 years ago, by Papi, of Florence, for the sculptor Balzico.

I do not recommend the establishment of large foundries in England for waste-wax casting. It is essentially a process that should be used for the production of small, rather than large works; and although Papi cast one of my own works, of colossal size, by this process, I do not think that, as a rule, the game is worth the candle; and I should always employ the piece-mould, as being much cheaper and quite as successful. For work up to life size, however, and especially for smaller work, where the touch of the artist is of great importance, I should always use the waste-wax process.

There is all the difference between a statuette cast from the wax by an artist and the same thing cast in a piece-mould in the ordinary way that there is between an original painting and a chromolithograph. The one may be worth more than its weight in gold, the other is hardly worth more than its weight as old brass. On the other hand it is not the wax process alone that gives value to the work; the design may be admirable, and the artist amongst the greatest; but if he allows inferior workmen in a foundry to re-touch the waxes and repair and chase up unsuccessful castings, then the work ceases to have artistic value, and is no longer an original autograph work, but simply a commercial copy.

It will be an excellent day for English sculpture, and I think that day is not far distant, when the public will insist on autograph work, in small bronzes at least. These may easily be cast with few appliances and in a very small studio. This is a bronze from the wax sketch of my marble statue of th Queen, which I cast in a corner of my own studio. It is left exactly as it came from the mould, and has not even received a patina only the jets and vents were removed. merely mention this to show that it may easil be done, and I hope the time may soon come when artists will again take their proper par in the advancement of bronze casting in Europe.

[The illustrations to Mr. Simonds's paper will b published as a supplement to the next number of th *Journal.*]

DISCUSSION.

The CHAIRMAN said he had listened with th greatest possible interest to the paper which Mr Simonds had been good enough to read to them Few who had not been engaged in art casting, or looking at a statue, knew how complicated the process was by which the result was obtained. It mad one envious to think that £3,000,000 could be spen on a work of art, as they had been told was the case in Roman times. It was true they now spen £3,000,000 on plates, but it was not bronze plates it was on armour plates for vessels. He though they did not realise what a suitable material bronze was even for the London atmosphere. They migh look at certain works of art which were allowed to undergo the corroding effects of the London atmosphere; but they did not look at those that were properly cared for, nor did they appoint officers o state to look after the works of art. Such works were left entirely to the care of children; and they had only to look at the sphinxes, which were no doubt that evening covered with children, in order to see that all the parts accessible to the children were in a most beautiful state of polish and preservation He should like to have seen some mention in the paper of a namesake of his, who lived in the year 1450; and he should also be glad to know if Mr. Simonds could tell them a little more about patina.

Mr. W. GOWLAND had listened with great pleasure to the able and interesting paper of Mr. Simonds; in fact, that gentleman had entered into the matter so fully that it would be quite presumptuous for him to criticise it. However, there was one question he should like to ask, and that was whether any information could be given as to the approximate date when the method known as burning in was first adopted for statues which were cast in pieces. He had been unable to find out satisfactorily the date when it first took place in Europe. The method of burning in had been practised in the East from very early times. It was first attempted about the 8th century in Japan, in casting a colossal statue, but en they did not unite the small segments with the me alloy, but they ran in between the edges an loy, which melted at a lower temperature. In the 3th century there was a very fine casting made out 43 feet in height, which weighed at least o tons, and this was cast in pieces, but the pieces ere afterwards united by running in an alloy of the me composition as themselves, so that practically is statue was one piece of metal. It was a very rious thing that, although nearly every structure in pan had been more or less injured by earthquakes, is statue, although in a district subject to the most vere earthquakes, was just as perfect as when it as finished by the founder, having now stood some x centuries. The method mentioned in the paper f pouring metal into a mould and then pressing the ore into it had been used also in Japan, and was use in works in this country, but merely for rough urposes. For instance, the moulds for casting opper ingots were made in that way. With regard the casting of the large statue referred to by Mr. imonds, he thought one of the chief reasons why was so very successful was because wood was used s fuel. If the metal of that statue had been melted ith coal, the statue would not have been satis- ictory, it would have been vesicular in many parts. Ie was glad to notice that Mr. Simonds advocated he casting of statues by the sculptor himself, for, ntil that really took place, they could not hope to ave first-class work. This course had been adopted Japan for several centuries. All the best cast- igs had been made by the sculptors themselves. hey did not merely make a model in modeller's wax, nd then have plaster casts made, and from these casts he castings in bronze, but they modelled the object n the core in the actual wax, which was afterwards ielted out, so that the casting bore all the delicate ouches of the sculptor's hand, and if it was uccessful it required no retouching whatever. He hought that the sculptors and bronze founders in his country laboured under very great disadvantages. t was needless to point out how very necessary it as that a sculptor and bronze founder should now something about the chemical and physi- al properties of the metals employed, and of the est methods of casting them. He regretted hat in this country there was no institution here a student could study the subject of metal- irgy as applied to art casting, or by attend- ig a course of lectures. In many art foundries— e would not say in all—nothing was known of the rst principles of casting. In an ordinary foundry ufficient care was not taken with regard to the election of the copper. The copper of the alloys or art castings should be of the purest descrip- ion. In most foundries they used what was called est selected copper, and this to a certain extent as fairly pure, but it was not always so. Very ften there was a larger quantity of arsenic in it han there ought to be. Then the zinc was never xamined, and sometimes there was as much as 2 per cent. of lead present in it, and it often contained cadmium which had a very injurious effect upon the casting, by making the alloy crystalline. The copper after being melted was too often exposed to the action of the gases from the fuel and absorbed sulphurous acid from them. It also absorbed oxygen from the air, and unless the metal was covered very thickly with charcoal you got melted copper saturated with oxide of copper, which again had an injurious effect upon the casting. This could be very easily prevented. When the copper was placed in the furnace large quantities of charcoal should be placed on the furnace bed, so that the surface of the copper after melting was never exposed to the action of the air, or of the furnace gas. But still this was not sufficient to prevent the copper from oxidising; therefore, after the whole of the copper was melted, it was always advisable to put in more charcoal, and then introduce a pole of green wood, in order to stir up the metal and bring every part of it in contact with the charcoal floating on its surface. When this was done, before adding the tin and zinc, you obtained a bronze which flowed with the greatest possible fluidity. Another fault which he had to find with most bronze founders was, that they used scrap. When making a casting, there was generally a lot of metal lying about in the foundry, the composition of which was not known; and although they weighed in the copper, zinc, and tin in proper proportions, they put in a certain amount of this scrap, which made the bronze ot unknown composition. Another point with regard to bronze casting which should be borne in mind was that when an art casting of any value had to be made the alloy should be made beforehand, and cast into ingots, and when the actual casting had to be made, the ingots should be melted, and the metal poured into the mould. One generally found in a bronze foundry that when castings were failures, the moulders were blamed. Sometimes this blame was deserved, but, as a rule, the failures were generally due to the neglect of one or more of the precautions which he had mentioned.

Mr. HUGH STANNUS said he was not aware that the paper would deal with prehistoric times, otherwise he would have verified some dates upon the subject. He had much to do with a bronze foundry at one time, and he had written a history of bronze casting, and he put what little knowledge he possessed into that treatise, after examining a great many bronzes in the British Museum, South Kensington, the Louvre at Paris, and the wonderful Japanese collection of the late M. Cernuschi. Mr. Simonds had spoken about the prehistoric moulds for spearheads, and he believed there were a large number of two-face moulds of this description. There is also at the British Museum a piece of stone, with a sunk shape in it to make the mould for an axe-head of about half an inch thick; and the axe-head was cast thin at one side, by laying the mould in an inclined position, when the metal finding its level was thin at the broad end of the axe. There were a great number of examples of failure in bronze casting in the prehistoric period, and he would suggest that students should examine some of these failures in the British Museum. Reference had been made to the early statuettes of the Greek times, and to their being made uncored; but some, he knew, were made cored. To explain this, he would draw attention to some of the vases in the British Museum, which undoubtedly had been cast by the wax-process. The way it was done was this: the shape of the vases was thrown solid in porous clay. When dry the model of the vase was dipped into melted wax, when a certain quantity of wax adhered to it. Bronze pegs were then pushed through the wax into the clay core for about half their length; and the whole was then covered with loam, and the wax melted out, leaving a space for the bronze. Statuettes were similarly first modelled in clay like the Tanagra figures, and then dipped into the melted wax, which added a thin coating all over them. That could be seen by looking at the limbs, which were thicker in proportion than they should be. If a statue were made with the wrists and ankles in proportion to the waist, and then dipped into wax, the wax being of the same thickness throughout, the limbs would not be in proportion. Probably the disproportionate thickness of the wrists and ankles was observed, and so the statuettes were modelled in clay or loam, to serve as the core, pared down to the thickness intended, dipped into the melted wax, which was touched-up, covered with loam, and the wax afterwards melted out. He thought one could see the moving mind of the sculptor in those early statuettes. There were some candlesticks at South Kensington Museum, the under side of which showed a curious alluvial surface, proving that they were made by the same process. It was interesting to hear what was said about the effigies in the Abbey. As to when piece-moulding first came into use, he might mention that Verrocchio (1432 to 1488) is credited by Vasari as having invented the method of piece-moulding, but he had not been able to verify this. As reference had been made to a clever casting in one piece by Papi of Florence, he might state that there was also one which had been done by Englishmen. One of the groups for the Wellington monument was cast in one piece, because Stevens would not have arms or legs cut off. In this group there were about 1,600 pieces in the mould, which was cast by two Englishmen, named Hunt and Matthews, under the direction of Mr. Young. At Paris it was the practice, in the mercantile bronzes, to carry the arms and legs off, bracelets and other ornaments being used to hide the junction. He believed they did not burn the arms in; they put them in sockets, and pegs were then driven in and chased over. He should be glad to know whether there was any earlier record of "burning-on" than the 17th century.

Mr. FLETCHER said he quite agreed with Simonds as regarded the formation of classes giving instruction with regard to fine art casti Having made some experiments with certain all of bronze, he found that bronze could be produ almost as white as silver. Small works of art co be made to look very beautiful by the blending metals. He produced some experiments which had made with the garments of a different colour fr the other portion. These specimens were han round for inspection, and Mr. Fletcher stated t he thought there was a great field open for casti of bronze in various colours. As regarded the use cadmium, he believed it had a deleterious effect up the metal in large castings, but he found that deepened the colour in small castings, making more resemble gold. A very good alloy to use v composed of 35 of tin to the remainder of copper.

The CHAIRMAN asked whether such an alloy v not brittle.

Mr. FLETCHER replied that it was rather britt His aim had been to produce an alloy which wo do for the particular classes of work to which he h referred.

Mr. SIMONDS regretted that he had not be aware that the Chairman's namesake had c statues, and he would take care this omission w corrected. As regarded patinas, he was unable give the Chairman any information, as that gent man knew more about the subject than any oth person in England. If one took bronze and simp pickled it, and got the metal clean—if it was a go metal—and constantly rubbed, you would very so get as fine a patina on it as could be seen in go Florentine bronze. He quite agreed with the remar of the Chairman as to the necessity for Lond statues being looked after. As to burning in, found that Cellini spoke of repairing faults in bron castings by pouring more heated metal on—pouri more than there need be, allowing part to run through the vent. There was burning on, but he d not speak of using it for attaching pieces. T earliest instance that he could remember of burni on was in the statue of Louis XV., erected Bordeaux, where a part of the casting ca out badly, and it was afterwards burnt on. T next instance was the statue of Peter the Great. T first time this statue was cast, through some defe in the earthing up, the mould cracked, and the met came out. The sculptor took the mould down, r modelled the top part, fired the whole thing afres and it burnt on perfectly. In modern practice believed this was frequently done. He did not kno the practice at Barbedienne's, in Paris, as he had n been in that foundry for 23 years, but he knew th they used to braze the arms on. He quite agre with the remarks of Mr. Gowland as to the form tion of oxides. Sculptors were unscientific. Th l certain things produced certain results without wing how it was done. The purity of the metal a most important matter, and he knew that it very wrong to use scrap. The fault of all young inners was to have too many jets so that the tal would run free. More castings were spoilt by pouring than cold pouring. If you did not put ents enough the castings could not be all right. sound principle to follow was, "When in doubt in more vents." As to dipping the core, this ctice had been adopted in Italy for many little icles, especially where turned cores were used, as candlesticks. He could not say when piece ulding was invented, though he knew that Cellini his "Due Trattate" had given an admirable ount of how to make a piece mould, thus showing t it was well known in his time, viz., 1500. With ard to the interesting copper alloys which had n produced by Mr. Fletcher he confessed he ew nothing at all about white brasses, never having d anything to do with them. It was essential that tatue in bronze should be of such ductile quality at any necessary repairs could be done. It was tter for artistic purposes that bronze should take a tina which would improve by time. The specins produced, however charming when bright, uld require to be kept so, but oxidation might duce results not desirable.

Mr. **Fletcher** remarked that the colour was y beautiful, even when oxidised.

The **Chairman** said he thought 5 per cent. of lmium was rather a large amount to use, but it by means followed that because a small amount was leterious, that a large amount would not be. They ght have an alloy of gold with 5 per cent. of zinc, ereas a smaller per-centage would make it very ttle. The temperature at which bronzes were t could always be ascertained if a pyrometer, ich had been described in that room on one occan were used. He was very glad to hear that they uld soon have published a translation of Cellini's ue Trattate." In conclusion, he proposed a rty vote of thanks to Mr. Simonds, which was t to the meeting and carried.

Miscellaneous.

CULTIVATION OF CACAO IN MEXICO.

An interesting report has been issued by the reign-office on the cultivation of cacao, vanilla, ia-rubber, indigo, and bananas, in Mexico, all of se crops flourishing in the warmer lands of the ublic. Mr. (now Sir Henry Nevill) Dering, Her jesty's Minister at Mexico, who supplies this ort—which is based on articles published from e to time by the Mexican Information Bureau—tes that he has been induced to forward it as he is opinion that the information respecting the cost of cultivation, the district in which each crop may be advantageously raised, as well as a statement of the pecuniary results to be obtained with proper care, may be valuable to many persons with small capital—say £1,000 to £2.000—who may be desirous of investing the same in a country offering exceptional advantages. He also adds that the necessary dwelling-house, or simple ranche, for personal occupation on a plot of ground purchased for the growth of any of the above crops, may be set up at an expense considerably less than the cost of an ordinary labourer's cottage in England. The cacao tree is a native of Mexico, and, long before the conquest, the Aztecs and other ancient Mexican tribes used the fruit as one of their alimentary beverages. They prepared a drink called "chocolatl" by mixing the seeds, after having crushed them together, with fine corn meal, vanilla ("tlilxochitl") and a species of spice called "mecaxochitl," and those who drank it were a picture of health. All nations subjugated under the Aztec Eagle had to bring among other valuables a certain number of bags of cacao to the palace in the great Tenochtitla as an annual tribute to the Emperor. It was so highly prized amongst the ancient natives that in trade it was utilised as currency among the lower classes. The varieties cultivated were the "quanhcahuatl," "mecacahuatl," "zochicucahuatl," and "tlacacahuatl." The bean of the last one was very small, analogous to the kind found at present at Soconusco, Chiapas. The tree is found growing wild and in cultivation in the States of Colima, Michoacan, Guerrero, Oaxaca, Chiapas, Tabasco, and central and southern Vera Cruz, where the elevation is from 100 to 1,200 feet above sea level, but Chiapas and Tabasco are noted as being its home, the climate and soil there being more particular adapted to its culture and development than any other portion of the globe. The species of cacao tree most cultivated in Mexico are—Cacao or *Theobroma ovalifolia*, *T. bicolor*, *T. augustifolia*. There are other kinds known, generally found growing wild, which come under the head of the Guazumæ or guacima, Guaznma polybotrya being the principal species. A warm, moist climate, having a mean temperature between 76° and 77° Fahrenheit, is necessary for the cultivation of cacao if large crops are expected, but when the soil is suitable the tree will grow and yield fair returns on a moderately dry or well drained place. The best elevation is from 300 to 500 feet, and in sheltered situations near the seashore good crops are to be obtained, but the tree will not thrive if exposed to the direct influence of the sea breeze. Cacao will not bear much exposure, hence sheltered lands and valleys should be selected, and on the Gulf side of Chiapas, Tabasco, and Vera Cruz northern and eastern aspects should be avoided. Cacao plants are obtained from the seed, which germinates readily and quickly, and the seed, when sown, is covered with vegetable mould or loose loam mixed with horse manure, and over that banana leaves. The bed is sprinkled every day for 12 or 15 days when seedlings appear. Then the banana leaves are removed, and sheds made of palm leaves and sticks, so fixed that they can be raised as the seedling grows, should be placed over the nursery as shade and shelter. A year after sowing, seedlings are about 20 inches high, and ready for transplanting. Returns from a cacao plantation cannot be expected until five years from transplanting. At two years years old the tree, on rich soil, stands 5 or 6 feet high; when 7 or 8 feet high it begins to bear, but it is not in full bearing until it is between 10 and 12 feet high. The average yield of dry cacao from each tree varies very much; the limits may be said to be from $1\frac{1}{2}$ to 8 lbs. per tree. Some trees in the plantation of "La Carolina," district of Macuspana, in Tabasco produce 220 pods and plantations in Alvarez, Colima, and in Apalzinghan, Michoacan yield on an average 5 lbs. to the tree. The pods having been gathered, are placed in heaps under the trees; they are then taken to a place, called quebradero, where they may be broken at once or left for a day. The kernels or nibs are then taken out of the pods which are either opened with a machete, or a knife made from a wood called Jahuate. As the seeds are extracted from the pods, the former are thrown into wooden troughs called "tollas," half filled with water, to wash them, and the beans are then carried away to the cacao house for the sweating or fermentation process. When the beans have been properly sweated, they are dried ready for shipment, and this drying process is complete as soon as they produce a crackling sensation when pressed between the thumb and forefinger, or when the parchment (outer skin) breaks off easily. As to cost and expense, generally, cacao planters in Chiapas and Tabasco make contracts, paying 90 to 100 dollars (Mexican dollar may be taken as equivalent to 2s. 2d.) per 1,000 trees, to be delivered in a state of production in four years, the plantation to be in good condition and with proper shade. The contractor keeps the products and first crop of the plantation. If the planter has his own labourers, he pays them from five to eight dollars per month and rations, then the cost will be from 70 to 80 dollars per 1,000 trees. When the labour is not done by contract but by "jornales" or tasks, the cost for six years per hectare (2·47 acres) is 191 dollars for 750 trees. The expense of collecting, drying, and sacking the seed is from three to five dollars per cargo of 60 lbs. Thus 750 trees will produce the planter 75 cargoes (4,500 lbs.), the price of which is from 20 to 22 dollars per cargo at the plantation. Deducting the cost of curing, he will have a net annual profit of more than 1,225 dollars, besides the produce obtained from side crops.

Obituary.

Dr. J. H. Middleton.—John Henry Middleton, M.A., Litt.D., D.C.L., the Director, of the Art
Museum at South Kensington, died on Wedn
day, 10th inst., at his residence in the Museu
Dr. Middleton was born at York, in 1846.
was Slade Professor of Fine Arts at Cambrid
from 1886 to 1892, and also Director of the Fi
william Museum and a Fellow of King's Colle
Cambridge. On his settlement in London as one
the Directors of the South Kensington Museum,
became a member of the Society of Arts.
Middleton was a Vice-President of the Society
Antiquaries at the time of his death. His wo
on Rome—"Ancient Rome" (1885), "Anci
Rome in 1888," and "Remains of Ancient Rome
about 1892—are the result of a life-long study
that city, and are of the highest value. He a
published, in 1891, "Engraved Gems of Classi
Times," and "Illuminated Manuscripts in Classi
and Mediæval Times" in 1892. He wrote a la
number of articles in the last edition of the *Encyc
pædia Britannica*, and contributed to the *Archa
logia*, the *Journal of Hellenic Studies*, &c.

General Notes.

Chicago Exhibition, 1893.—The medals a
diplomas awarded to British exhibitors at Chica
have at length been issued to H.B.M. Ambassa
at Washington, and have been transmitted by h
to the Foreign Office. Sir Henry Trueman Wo
has been requested by the Secretary of State
undertake the duty of distributing them, and t
will be done at once. All the exhibitors may exp
to receive their medals within about a month fr
the present date.

MEETINGS FOR THE ENSUING WEE

Monday, June 22 ... Geographical, University of Lond
Burlington-gardens, W., $8\frac{1}{2}$ p.m.
British Architects, 9, Conduit-street, W., 8 p m.
Tuesday, June 23 ... Photographic, 12, Hanover-square,
8 p.m. Mr. F. E. Ives, "A Practical Demonst
tion of Colour Screen-making and Testing."
East India Association, Westminster Town H
S.W., 3 p.m. Captain Frank Younghusba
"India and Africa."
Wednesday, June 24 ... SOCIETY OF ARTS, 4 p
Annual General Meeting.
Geological, Burlington-house, 8 p.m.
United Service Institute, Whitehall, S.W., $3\frac{1}{2}$ p
Major A. B. Williams, "The Evolution of
Militia."
Royal Society of Literature, 20, Hanover-square,
8 p.m.
Friday, June 26 ... United Service Inst., Whitehall, S.
$3\frac{1}{2}$ p.m. Capt. W. H. Harrison, "The Invasi
of England—should London be Fortified?"
Physical, Chemical Society's Rooms, Burlingt
house, W., 5 p.m. 1. Mr. F. Bedell, "Admitta
and Impedance." 2. Mr. S. P. Thompson, "T
Properties of a Body having Negative Resistanc
3. Mr. H. F. Burstall, "Resistances of B
Wire."

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FRIDAY, JUNE 26, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1896.

The results are now ready, and have been sued to the various centres of examination. opies of the list have also been sent for disibution to the successful candidates.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving e report of the Council, and the Treasurers' tatement of Receipts, Payments, and Expeniture during the past year, and also for the lection of Officers, was held, in accordance ith the Bye-laws, on Wednesday last, the th June, at four p.m., Major-General Sir OHN DONNELLY, K.C.B., Chairman of the ouncil, in the chair.

The SECRETARY read the notice convening e meeting, and the minutes.

The following candidates were proposed, allotted for, and duly elected members of the ociety :—

arrett, Frederic, Rosefield, Staines.
erry, Walter W., Gushmere-court, Selling, near Faversham, Kent.
ridges, William Francis, Georgetown Club, Demerara.
ritton, Philip William Poole, Bitton-house, Bycullah-avenue, Enfield, and 51, Lincoln's-inn-fields, W.C.
rown, Thomas Forster, Guildhall-chambers, Cardiff.
aine, Charles Q., Grosvenor-chambers, Deansgate, Manchester.
handabhoy, Munchershah Nusserwanjee, Victoria-buildings, Fort, Bombay.
handabhoy, Shapoorjee Nusserwanjee, Victoria-buildings, Fort, Bombay.
ox, Henry, Chaseley, Cazenove-road, N., and Junior Constitutional Club, Piccadilly, W.
Eddy, Edward Miller Gard, Chief Commissioner for Railways, Sydney, N.S.W.
Elliott, Sir Charles A., K.C.S.I., 43, Cromwell-houses, S.W.
Firnberg, Max, 2, Lancaster-place, Belsize-park, N.W.
Forster, John, Oriental Club, Hanover-square, W.
Fox, Edwin Marshall, 34, Victoria-street, S.W.
Gratton, Frederick Montague, 16, The Bund, Shanghai.
Hargreaves, T. Sydney, Institute of Mines and Forests, Georgetown, British Guiana.
Hose, Charles, Baram, Sarawak, Borneo.
Kirkwood, James, Imperial Customs, Kowloon, Hongkong.
Lawrence, Walter Roper, C.I.E., 22, Sloane-gardens, S.W.
Ludwig, Frederick Augustus, 5A, Pall-mall East, S.W.
Maxim, Hudson, 55, Charing-cross-mansions, W.C.
Mitchell, His Excellency Lt.-Col. Sir Charles B. H., G.C.M.G., Government-house, Singapore.
Mizzi, Cav. Uff. M.A.M., Gozo, Malta.
O'Donoghue, Freeman M., 9, Charles-street, St. James's-square, S.W.
Pearson, Sir Weetman D., Bart., M.P., 10, Victoria-street, S.W.
Perry, Charles Edward, Canadian Pacific Railway, New Denver, British Columbia.
Playfair, George Gedge, Riverside, Lewisham, S.E.
Price, Charles, 1, Kent-terrace, Regent's-park, N.W., and 12, Conduit-street, W.
St. Cyr, E. L. N., Aux Cayes (Hayti), West Indies.
Salter, John, 5, Raleigh-road, Exeter.
Twopeny, Edward Maxwell, Woodstock, Sittingbourne.
Wilkinson, R. J., Penang, Straits Settlements.
Young, J. Denholm, 2A, Tower-chambers, Old Church-yard, Liverpool.

The CHAIRMAN nominated Mr. John Jewell Vezey and Mr. A. Barclay, scrutineers, and declared the ballot open.

The SECRETARY then read the following

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

The 142nd Session of the Society commenced in November last in the usual manner, with an address by the Chairman of the Council, Sir John Donnelly. Sir John made Technical Education the subject of his address, dealing with it as defined in the Technical Instruction Act of 1889, and giving an account of the means which now exist for providing technical education as so defined. He called special attention to the fact that by far the larger part of the funds expended by local authorities, and of the grants from the Science and Art Department, were expended on instruction given in evening classes, for the benefit of those who had left school and were wholly or in part earning their own living; this development of secondary and technical instruction being very different from that which obtained on the Continent even in those countries in which secondary instruction as usually understood—that is to say, of boys and girls still *in statu pupillari*—was more organised than in this country. In concluding his address he laid stress on the necessity for some central organisation to which local authorities could appeal for assistance in examination and for inspection and advice—an organisation which might help to co-ordinate the various agencies now at work for providing examination and otherwise promoting technical instruction.

At the first regular meeting of the Society after the opening meeting, Mr. H. H. Cunynghame read a paper on "Locomotive Carriages for Common Roads," a subject which was also dealt with in a course of Cantor Lectures by Mr. Beaumont. The subject is one of great and growing interest, although, as has been pointed out over and over again, no progress can be expected in this country until the way is clear from the statutory obstructions which now exist, and which it is hoped to remove by the Bill now before Parliament. The discussion on Mr. Cunynghame's paper occupied a second evening.

The next paper was by Mrs. Lea Merritt and Professor Roberts-Austen, on "Mural Painting by the Aid of Soluble Silicates and Metallic Oxides." The method dealt with was the one brought before the Society in 1884 by the Rev. J. A. Rivington, a method which has since been developed and improved, and which, it is to be hoped, will give more satisfactory results than the silicate process employed for the decoration of the Houses of Parliament at Westminster. Professor Roberts-Austen drew the attention of the meeting to some paintings in the Church of St. Martin's, Wonersh, which he had been instrumental in providing.

The other paper read during the portion of the Session before Christmas was by Mr. John Southward, on "Machines for Composing Letter-press Printing Surfaces." Mr. Southward gave an account of the progress which has been made in replacing the handwork of the compositor by the work of a machine, and showed to what a large extent machines were now employed for this purpose both in this country and in America.

When the Session was resumed after Christmas, the first paper read was by Professor Silvanus Thompson, his subject being "T Making of a Great University for London Professor Thompson gave some valuable a elaborate statistics of the income and expen ture of a number of universities and teachi institutions, and strongly supported the sche for dealing with the existing University London proposed by the second Royal Co mission, under Lord Cowper.

Another paper of an educational charac was read a little later in the session by M H. Macan, his subject being the "Report the Royal Commission on Secondary Educ tion." Mr. Macan's paper was a defence the report against the objections which ha been raised to it, and a criticism on the exi ing system of private schools in this country

A somewhat large proportion of the pape read during the Session dealt with subje of an engineering character. The first these was read in January, by Mr. Frank V Grierson, on the "Supply of Sea Water London," a proposal which seems to somewhat nearer realisation than would ha been thought possible some years ag The proposal is to take the water from point near Lancing, between Brighton a Worthing, where it would be pumped to reservoir of sufficient height to enable t water to flow by gravitation to Epsom. The it would be received in a reservoir 200 fe above high water, and therefore have sufficie head to allow the sea water to be distribut without further pumping, to London.

A fortnight later Mr. F. H. Cheesewrig read a paper on "The Mexican Draina Canal," a great work for the drainage of t valley of Mexico, which was commenced the Aztecs some 500 years ago, and has on just been brought to practical completion.

Mr. F. A. Anderson, in his paper on "Wat Purification by Means of Metallic Iron," ga an account of the development of the proce which was brought before the notice of t Society, in 1886, by his father, Dr. Willia Anderson, and showed what successful resul had been attained at Antwerp, where the fir installation of the process was made, and als in Holland, India, and France, as well as i this country.

The other paper which may be included i this rough classification is the one on "Tunnelling by Compressed Air," read by Mr. E W. Moir, in May. Mr. Moir had charge f the contractors, Messrs. S. Pearson and Son of the Hudson River Tunnel, and has now th supervision of the Blackwall Tunnel. He gav

very concise yet full account of the great
lvance which has been made in sub-aqueous
nnelling since Brunel first employed a shield
the construction of the Thames Tunnel.

Four papers were more or less closely con-
cted with photographic matters. Of these
e most popular and interesting was that
Mr. Campbell Swinton on "Röntgen's
hotography of the Invisible." It was read
ry soon after the first description by Pro-
ssor Röntgen of the mysterious rays which
had discovered, and attracted a great deal
interest.

In April, Mr. Ives, who had on two previous
casions, in 1892 and in 1893, brought the
bject before the Society, read a paper on his
Photochromoscope and its Colour Photo-
aphs," and showed the improvements which
has made in this very ingenious instru-
ent. It is now capable of being used
ereoscopically, and increased vividness and
stinction are, therefore, given to the com-
ned colour images. Captain Abney's paper
"Orthochromatic Photography" was read
the last meeting of the Session. It gave
extremely clear account of the objects
ught to be obtained by orthochromatic pro-
sses, which render colours truly in monotone,
d the methods employed to attain those
jects.

Mr. Dibdin's paper, read in January, on
Standards of Light" may be classified
nong the photographic papers, although the
otographic applications of the subject are
t the most important. Mr. Dibdin dis-
ssed the Report of the Committee appointed
the Board of Trade to deal with the sub-
ct of standards of light, and he supported
e conclusion of the Committee that the
ntane air flame should be employed as
standard, this flame being produced by a
rner invented by Mr. Dibdin in continuation
Mr. Vernon Harcourt's researches.

Two papers dealt with musical subjects, that
Mr. A. J. Hipkins on "Musical Pitch,"
d that by Mr. Burnham Horner on "Early
nglish Organ Writers." Mr. Hipkins pro-
unced in favour of the French pitch, the
apason normal, the adoption of which was
commended by the Society of Arts in 1886,
d in favour of which the Philharmonic So-
ety have now discarded their own pitch. The
eatment of Mr. Horner's paper was mainly
istorical; it was of considerable interest to
l lovers of the organ.

In March, Professor James Long read an
nportant paper on "Our Food Supply, as affected by the Farming of the Future." It was satisfactory to learn that so capable an authority thought that there were chances of a more prosperous condition of home agriculture. Another paper dealing with food supplies was that by Mr. Edward W. Badger on "Fruit and Vegetable Drying." Mr. Badger strongly recommended the application of the system now common in America by which fruit is artificially dried, to the products of English orchards.

Dr. Morris's paper on the "Bahamas Sisal Industry" gave an interesting and useful account of the progress which has been made in developing this new fibre plant in the Bahamas.

Professor Haddon's paper on "Peasant Life and Industries in Ireland" was a graphic account of the mode of life and the domestic industries of the peasants of the West and North of Ireland. It was very fully illustrated with a number of photographic views of the country and its people.

Mr. Hudson Maxim's paper on "High Explosives and Smokeless Powders" gave an account of the progress which has been made, principally in America, in the use of shells filled with high explosives, and in the guns required to throw such shells.

II.—INDIAN SECTION.

The Session of the Indian Section began on January 16 with an excellent and timely paper by a distinguished member of the Indian Survey Department, Colonel R. G. Woodthorpe, R.E., on "The Shan Hills: their Peoples and Products." The agreement just previously entered into by Great Britain and France, defining their respective spheres of influence in Indo-China, was engrossing the public mind, and Colonel Woodthorpe's paper, giving the results of his observations when engaged in the Mekong Valley as a member of the Scott Delimitation Commission, attracted special attention both here and in India. Colonel Woodthorpe spoke encouragingly of the future possibilities of the Shan States, but pointed out that further "expert exploration" is required, his views being endorsed by Lord Lamington. On February 13 Sir James Broadwood Lyall read a valuable paper on "Punjab Irrigation: Ancient and Modern," advancing the proposition that in the arid northern province irrigation canals are, first, much more generally necessary; second, much more of an unmixed benefit; third, more likely to be profitable to Government; and, fourth, capable of much greater extension than in other parts of India. The paper included not only an elaborate description of the various systems of irrigation employed in the Punjab, but also a very useful account of some projected canals of considerable importance, and concluded by urging that "the great work done by the canal engineers deserves more appreciation and encouragement than it gets at present either in India or in England."

On February 27 Mr. C. Tripp read an admirable paper on "The Tobacco Industry of India and the Far East," based on the practical experience he acquired during a residence of some years' duration in Sumatra, which he styled "the most prosperous tobacco-producing country in the world." Mr. Tripp made various suggestions for the improvement of Indian methods of cultivation. On March 19 a paper, graphically describing the remarkable flood of 1893 in the Garhwal district of the North-Western Provinces, and narrating the extensive measures so successfully adopted for the preservation of human life, was contributed by Mr. J. H. Glass, Chief Engineer and Secretary, Public Works Department, Bengal.

On March 26, Mr. Walter R. Lawrence, I.C.S., contributed a picturesque paper on "Kashmir: its People and its Products." With reference to the latter, Mr. Lawrence mentioned that the first supply of Kashmir silk had found a sale in London a few weeks before, and that European energy, skill, and capital are alone needed to make the "Happy Valley" the California of India. On April 23 Captain Charles Rolleston read an interesting paper on "The Deserted City of Vijayanagar," once the capital of an important kingdom in Southern India; and on May 14 the Session terminated with an able and exhaustive paper on "Tea Planting in Darjeeling," by a well-known Indian planter, Mr. George W. Christison. Three of the meetings of this Section were held, as in the two preceding years, at the Imperial Institute.

III.—FOREIGN AND COLONIAL SECTION.

Six meetings of this Section were held during the Session. On December 17th, a paper was read by Mr. Frank Cundall entitled "Jamaica in the Past and Present." An interesting account was given of the history, geography, and commerce of this island, and views of the scenery were shown. On January 28th, Mr. Richard Davey, in a paper entitled "Stamboul: Old and New," described the people, buildings, and monuments of Constantinople. He pointed out that many of t articles in daily use, such as clothing a shoes, are imported from Germany and Au tria, to the total exclusion of Great Brita On February 18th, Mr. H. F. Parshall read paper on the "Development of Electri Traction Apparatus in the United States and fully explained the different classes motors used in this rapidly growing indust

At the meeting on March 3rd, Mr. Sc Elliot read a paper on "The Commerc Prospects in British Central and East Africa Besides being an interesting record of trav the paper gives valuable information as those portions of the country which are su able for European settlements. On Mar 24th, the subject of the paper was "T Colonies and the Supply of Dairy Produce a Products of Petite Culture." The reader, M Charles R. Valentine, gave an exhausti account of this rapidly increasing trade fr its commencement to the present time.

The last meeting was held on May 5th, wh a paper by Mr. James F. Dowling, on "Au tralia's Prospects in British Markets," w read, special reference being made to the me trade, and its prospects of development. A interesting discussion followed, wherein val able advice was given as to the necessity f improved means being adopted for packi perishable products, and also for the prom distribution of these products on their arriv at ports in the United Kingdom.

IV.—APPLIED ART SECTION.

The improvement of late years in the artist character of the pictorial advertising post has brought it within the province of t Applied Art Section. At the first meeting, January, Mr. Gleeson White read a valuab paper on the "Poster and its Artistic Po sibilities," in which was given an accou of the various artists, in this country a abroad, who have done something to make t walls of great cities popular picture gallerie Mr. White gathered together a remarkab collection of these posters as an exhibition, illustrate his paper, which was highly appre ciated.

At the next meeting Mr. F. Inigo Thoma read an interesting paper on the "Garden Relation to the House," in which he claime due appreciation for the formal garden, a urged that the architect should plan the garde in harmony with the house. Mr. Thoma illustrated his paper with a fine collection tern slides, showing specimens of historical rdens, as well as modern examples.

The third meeting of the Section was cupied by an account, by Mr. William rton, of the history of glazes and the lour possibilities in pottery, under the title "The Palette of the Potter." A collection historical specimens of pottery was lent by Science and Art Department, and this r. Burton used to illustrate the various ints raised by him in relation to mechanical rfection, and the uncertainty that must vays attend the processes of the potter.

Mr. Joseph Pennell read, on March 10, a ggestive paper on "English Book Illustra- n, 1860-70," in which he pointed out how illiant a period this was in the history of ok illustration, showing from the pages of *nce a Week, The Cornhill Magazine,* and her periodicals, as well as from the illustrated itions of "Don Quixote," "The Arabian ghts," &c., the high character of the work. that time, Millais, Whistler, Holman Hunt, Boyd Houghton, Frederick Sandys, Keene, alker, Pinwell, and many other artists of the nt rank, were producing fine work for these blications. Mr. Pennell affirmed that there re more good illustrated magazines issued 1865 in England than there are to-day in e whole world.

The next paper, on May 12, was by Mr. scombe Gardner, on "Wood Engraving as mpared with other reproductive Arts, and its ture as a Fine Art," in which he pleaded r the official recognition at the Royal cademy of the artistic position of wood graving, claiming for the art a power of re- oducing the artist's *technique* superior to all e other reproductive arts. Mr. Gardner illus- ated his paper with a fine collection of wood gravings.

At the last meeting, on May 19, Mr. George monds read an instructive paper on "Bronze asting in Europe," in which he gave the story of some of the chief examples of Euro- an bronze statues. This paper forms a con- nuation of the paper read by Mr. Simonds fore the Society on February 3, 1886, and ay be considered as a complement of Mr. owland's paper, read last Session, on "The rt of Casting Bronze in Japan." Mr. monds's paper was illustrated by a series of ntern slides showing the processes of bronze sting.

V.—CANTOR LECTURES.

The first course of Cantor lectures was by Mr. Worby Beaumont on "Mechanical Road Carriages," a subject then and since attracting a large amount of interest. Mr. Beaumont dealt slightly with the history of the subject, showing how much advance had been made in mechanical carriages for common roads before the universal introduction of railways had drawn the attention of engineers away from the application of motive-power on common roads. He also described the more recent inventions for utilising the power of steam, gas, or electricity for road locomotion.

In the second course, Dr. Fleming dealt with a subject of great importance to electricians, the use of "Alternate Current Transformers." The lectures dealt with the action of the transformer, its construction, method of testing, and employment.

The third course was by Professor J. M. Thomson on "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." This is a subject which has already been dealt with to a certain extent in Cantor lectures, Mr. Dent having in the year 1887 given a course on "Building Materials." Professor Thomson, however, kept his lectures more to the purely chemical side of the question.

Professor Henry Miers, in the fourth course, on "Precious Stones," showed how the various stones could be discriminated from one another, and from their imitations; and described the most recent method by the use of heavy liquids, the specific gravity of which may be made greater or less than the stone, so as to afford a trustworthy test.

The last course of the Session was by Mr. James Swinburne on "Applied Electro-Chemistry." The great importance of mechanical applications of electricity have to some extent diverted public attention from its chemical applications, although these were really the first which were made of any practical utility. As electro-chemistry is taking a more and more important place among the practical applications of electricity, Mr. Swinburne's lectures had a special value to the younger students of this subject.

VI.—JUVENILE LECTURES.

The Juvenile lectures for the present Session were given by Professor John Milne, his subject being "Earthquakes, Earth Movements, and Volcanoes." Professor Milne is admitted to be the highest authority on such matters, his long residence in Japan having given him specially favourable opportunities for the investigation of the subject. He showed how earth movements were now observed and recorded, and gave a very good general idea of the progress which had been made in the investigation of a little known, though very important, branch of science.

VII.—ALBERT MEDAL.

The Albert Medal for the present year has been awarded, with the approval of H.R.H. The Prince of Wales, the President of the Society, to Professor David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

There are few, if any, telegraphic instruments which have had such extended use over so long a period as the Hughes type-printer. It was patented in the United States as far back as 1855, and is still extensively used in England and on the continent of Europe. To the general public Professor Hughes is perhaps better known as the inventor of the microphone, an invention freely given to the world, although, since some modification of it forms part of every telephone transmitter, it was of very great pecuniary value. Another important invention which, like that of the microphone, was not patented, is the use of twisted wires for long distance telephony, so as to prevent induction from adjacent lines. Professor Hughes has also produced many inventions which have not received such wide practical application, but still have been of the highest value in extending electrical knowledge; principal among these may perhaps be mentioned the induction balance.

VIII.—MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1895-96.

At the Ordinary Meetings:—

To W. J. DIBDIN, F.C.S., for his paper on "Standards of Light."

To A. J. HIPKINS, for his paper on "The Standard for Musical Pitch."

To A. A. CAMPBELL SWINTON, for his paper on "Röntgen's Photography of the Invisible."

To DR. D. MORRIS, C.M.G., M.A., for his paper on "Bahamas Sisal Industry."

To EDWARD W. BADGER, for his paper on "Fruit and Vegetable Drying."

To E. W. MOIR, M.Inst.C.E., for his paper on "Tunnelling by Compressed Air."

In the Indian Section:—

To COLONEL R. G. WOODTHORPE, C.B., R.I for his paper on "The Shan Hills: their Peoples a Products."

To J. H. GLASS, C.I.E., for his paper on "T Great Landslip at Gohna, in Gurhwal, and t Measures adopted to Prevent Serious Loss of Life

To G. W. CHRISTISON, for his paper on "T Planting in Darjeeling."

In the Foreign and Colonial Section:—

To FRANK CUNDALL, for his paper on "Jamai in the Past and Present."

To G. SCOTT ELLIOT, for his paper on "Th Commercial Prospects of English East Africa a British Central Africa."

To CHARLES R. VALENTINE, for his paper "The Colonies and the Supply of Dairy Produce an Products of Petite Culture."

In the Applied Art Section:—

To GLEESON WHITE, for his paper on "Th Poster and its Artistic Possibilities."

To WILLIAM BURTON, F.C.S., for his paper o "The Palette of the Potter."

To GEORGE SIMONDS, for his paper on "Bronz Casting in Europe."

The thanks of the Council were also voted t the following members of the Council:—

To PROF. W. CHANDLER ROBERTS-AUSTE C.B., F.R.S., for the paper by himself and Mr LEA MERRITT on "Mural Painting, by the Aid c Metallic Oxides."

To CAPT. W. DE W. ABNEY, C.B., F.R.S., fo his paper on "Orthochromatic Photography."

IX.—OWEN JONES PRIZES.

These prizes have now been awarded annually for 19 years, the first award having bee made in 1878. The Council of the Society o Arts are trustees of the sum of £400, presente to them by the Owen Jones Memorial Committee, being the balance of subscriptions t that fund, upon condition of their expendin the interest thereof in prizes to "Students o the Schools of Art who, in actual competition produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were awarded this Session, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The list of the successful candidates was given in the *Journal*.*

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* See *Journal*, Sept. 20, 1895, vol. xliii., p. 881.

The next award will be made this summer, the result of the present year's examinans. Six Prizes have again been offered for mpetition.

X.—MULREADY PRIZE.

After the death of Mulready, in 1863, a fund is formed to establish a memorial to him. r Henry Cole was treasurer of this fund. ie greater part of it was expended in erect- g a monument over Mulready's grave in ensal-green Cemetery. The balance, £109, is presented to the Society of Arts with the ew of a Mulready Medal being presented casionally to the student who should exhibit e best drawing from the nude at the usual aminations of the Department.

The Medal has been awarded on several casions, the last occasion being in 1893. It now offered for competition amongst students Schools of Art in the United Kingdom, at e annual competition to be held this year, e Science and Art Department having underken that its examiners should make the vard.*

The result of the competition is not yet iown, but it will be announced in the *ournal* as soon as the information is reived from the Department.

XI.—STOCK PRIZE.

In 1781 John Stock left £100 Consols to the ociety, with the condition that the interest iould be applied for the promotion of draw- g, sculpture, and architecture. From time time, as the accumulated funds permitted, izes have been offered under this head, the st award having been made in 1893. A old Medal, or a prize of £20, is now offered* r competition among the students of the hools of Art at the annual competition of 97. The prize is offered for the best original esign for an architectural decoration suitable r the interior of a building.

The Council believe that the prize can be ore usefully applied by restricting the cometition to schools of art than by offering it enerally, without restrictions, it having been und in practice that, when a general offer as made, without any limits whatever, the mpetition was extremely small, and the sults unsatisfactory. As in the case of the wen Jones and Mulready prizes, the Science id Art Department have undertaken that eir examiners shall make the award.

XII.—FOTHERGILL PRIZE.

The Fothergill prize dates from 1821, £388 having been left by Dr. Fothergill to be awarded in medals or premiums for promoting useful arts. In the bequest the testator suggested for consideration certain objects, all relating to the prevention of fire, and the Council have thought it desirable that the prize should occasionally be offered for purposes consonant with the desires of the testator, as expressed in his will. They have, therefore, offered the prize for an essay or paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire."* It is proposed that the paper, if suitable, may be read and discussed at one of the Society's ordinary meetings.

XIII.—PRIZE FOR INDUSTRIAL HYGIENE.

Mr. Benjamin Shaw, who died in 1887, presented to the Society a sum of £133 6s. 8d. Consols with the view of founding a prize of £20 to be given for Industrial Hygiene every five years. Though it has been offered several times, it has only twice been awarded.

The Council have announced an offer of the prize this year,† and they trust that some invention worthy of the award may be submitted to them.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

XIV.—PRIZES FOR DRAWING.

Since 1889, the Council have placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and, as usual, these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

XV.—EXAMINATIONS.

The rapid increase which has been noticed of late years in the number of candidates entering for the Society's Examinations still continues, as is shown by the following short Table :—

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* Particulars of the offer will be found in the *Journal* for nuary 10, 1896, vol. xliv., p. 149.

* Particulars of the offer will be found in the *Journal* for April 17th, 1896, vol. xliv., p. 505.

† See *Journal*, June 5, 1896, vol. xliv. p. 611.

Year.	No. of Candidates.	No. of Papers worked.	No. of Centres.	No. of Subjects.
1890........	2,315	2,474	79	14
1891........	2,460	2,667	78	14
1892........	*2,928	3,143	96	13
1893........	3,702	3,916	109	13
1894........	4,106	4,376	131	14
1895........	4,777	5,108	146	14
1896........	6,111	6,568	197	16

* Total, with supplementary autumn examination, 3,351.

Indeed, the rate of increase for the present year is greater than that of any previous year, the number of papers worked being 1,460 in excess of those worked in 1895. During the past five years the number of candidates has more than doubled, and there seems every reason to believe that the numbers entering will be still further extended in future years. It may also be pointed out that the number of examination centres has increased in a similar proportion, there being now just twice as many as in 1892.

This great increase is due, as has been pointed out in previous Reports, to the fact that the County Councils have had placed at their disposal large funds available for the promotion of Technical Education, and that Technical Education has been so defined by the Technical Education Act as to include the commercial subjects in which the Society of Arts holds its examinations.

It is satisfactory to note that, with so large an increase of numbers, the qualifications of the candidates show but a slight deterioration. The per-centage of first-class certificates (12·5) is a little lower than that of recent years, and the per-centage of candidates who have not passed has risen considerably, amounting now to 30 per cent., whereas last year it was only 21. On the other hand the per-centage of candidates who take second and third-class certificates has risen a little.

There are 124 subjects sanctioned by minutes of the Science and Art Department under the Technical Instruction Act of 1889. Of these 124 subjects a great majority are purely technical, and are dealt with in the examinations of the City and Guilds of London Institute. The classification adopted by the City Guil Institute and by the Department are som what different, but it may be said that the subjects of the Guilds' examination are prac cally covered by 45 in the Science and A Department list. This list also includes the 20 subjects of the Society's examinati (except English and Arithmetic), although th are so arranged (all the modern languag being included under one head) as to con into 9 of the list of the Department. A lar proportion of the subjects not dealt with by t Guilds Institute or the Society are eith agricultural or connected with industrial ar For all of these no general examinations a provided by any public institution.

Of the other important bodies whose exam nations might be held to cover more or le the ground are the London Chamber of Con merce, the College of Preceptors, the S John's Ambulance Association, the Roy Academy of Music, the Royal College Music, and Trinity College. Other instit tions, such as the Royal Agricultural Societ the Royal Veterinary College, the Pharm ceutical Society, and the Sanitary Institut hold examinations of a purely profession character, which, though dealing with t same subjects, would not be applicable for t same class of students as those intended to assisted under the Technical Instruction Act.

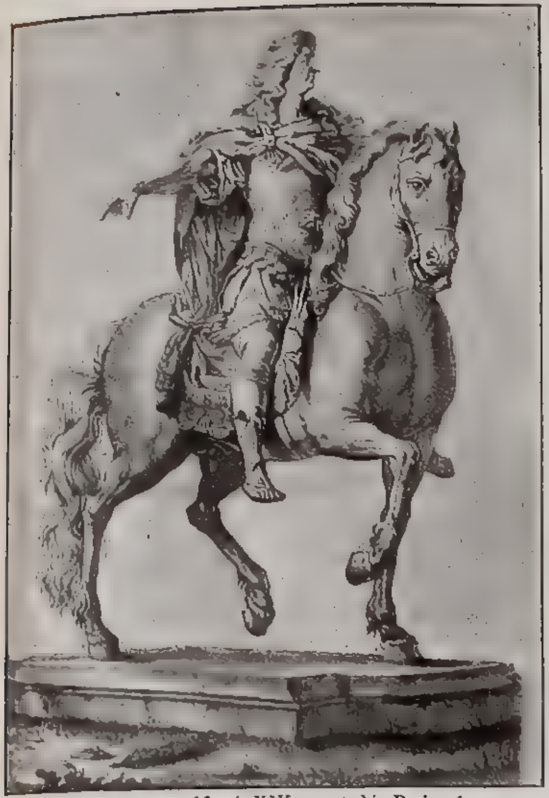
In order to make the Society's examinatio more fully representative of the Science an Art Department's list, two new subjects we added this year—" Economics " and " Préci writing." The Council were fortunate securing the services of Mr. Hewins (Direct of the London School of Economics) as e aminer for the first-named subject, and thos of Mr. Paul (of the Civil Service Commissio as examiner in the second.

The examiner in Spanish finds that most the candidates have shown a good knowled of commercial technicality. He notices a wa of literary capacity in the answers of many the candidates.

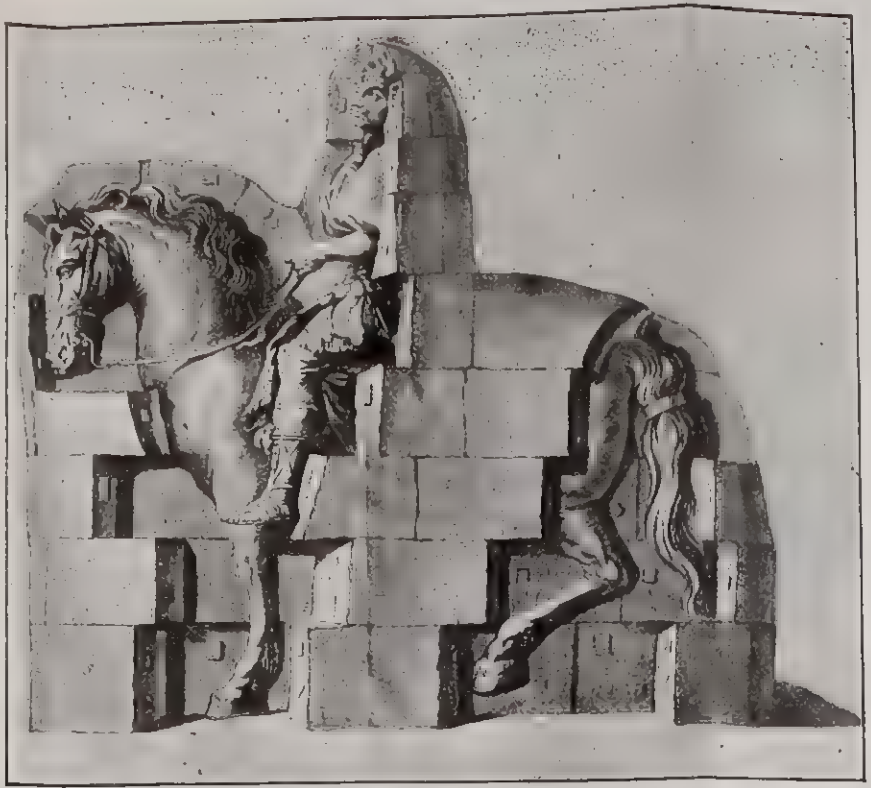
In Domestic Economy, the examiner note with pleasure that the quality of the papers, a well as their number, have improved. Man of the papers are excellent, showing a con siderable knowledge of the subject.

With regard to Rudiments of Music, th examiner states that most of the candidate for the elementary certificates showed goo training. The unsuccessful candidates wer weak in naming intervals, transposing, and i barring rhythmic passages. Many of the

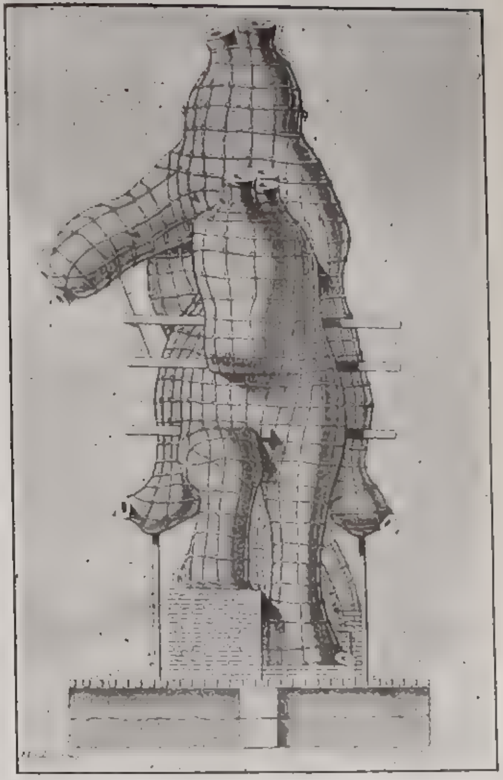
ILLUSTRATIONS TO MR. SIMONDS'S PAPER ON "THE ART OF BRONZE CASTING IN EUROPE."



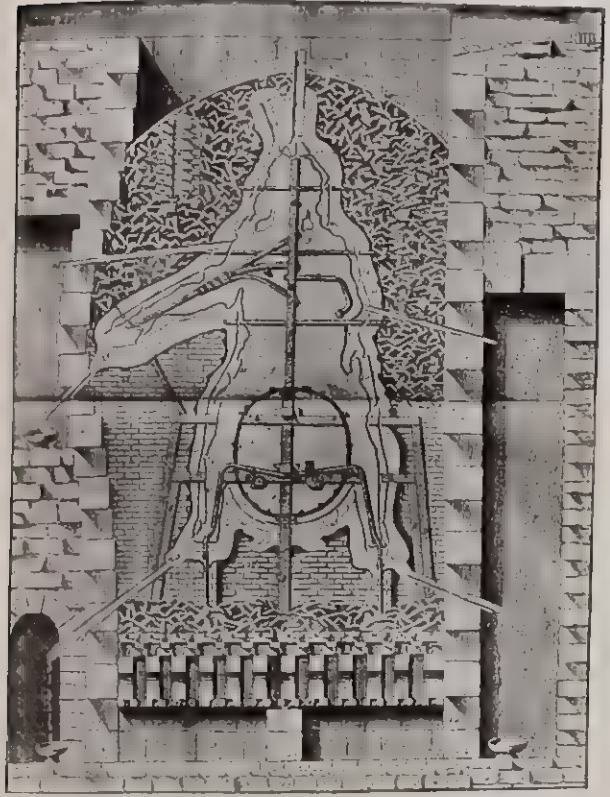
Equestrian Statue of Louis XIV., erected in Paris, 1699.



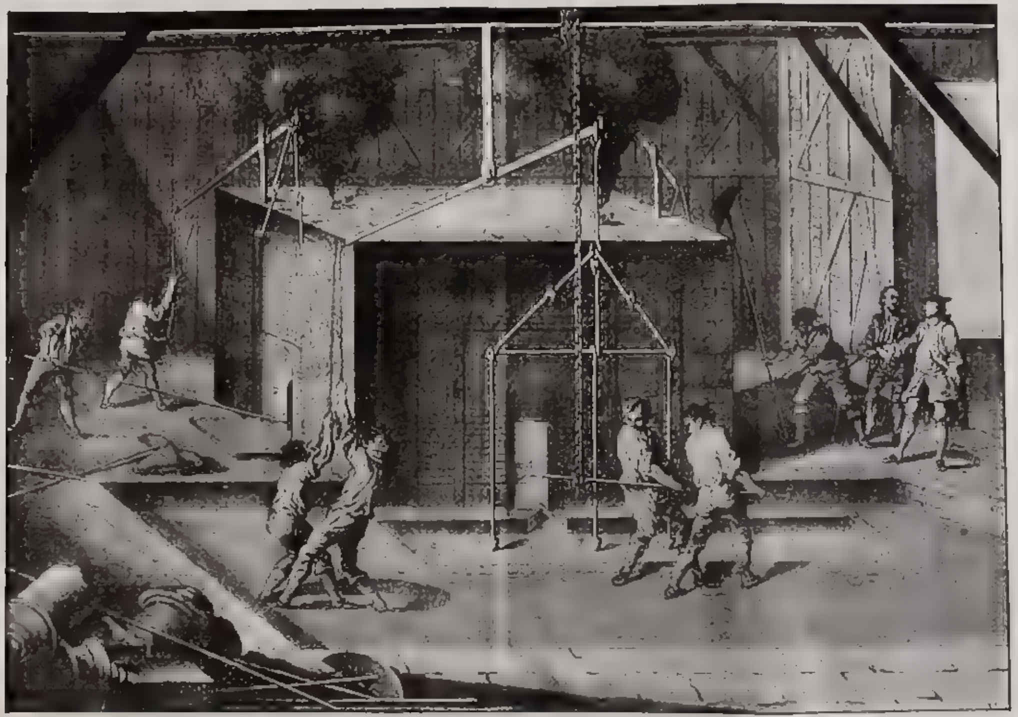
Plaster Model of Statue of Louis XIV., partially enveloped in Plaster Mould, formed in Sections, for the production of the Wax Model.



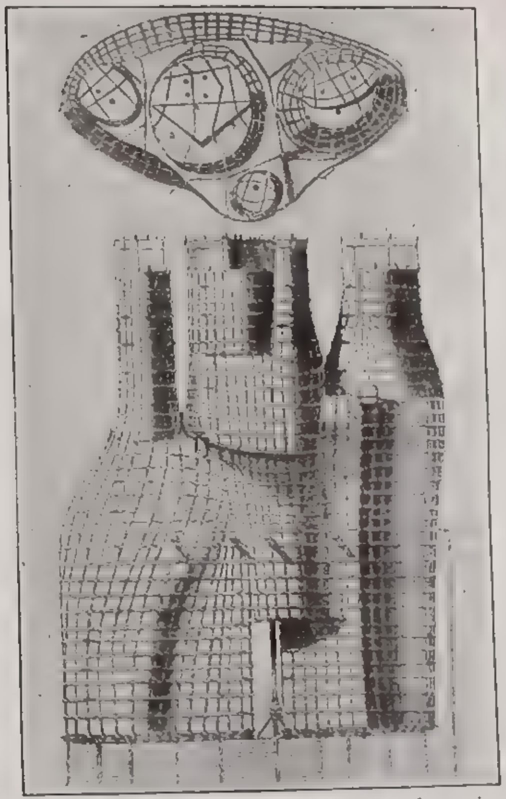
Front view of Mould, with iron bands, for casting the Bronze Statue of Louis XIV.



Section of Kiln, Mould, and Wax Model of Statue of Louis XIV., showing the Spouts provided for drawing off the Melted Wax.



Tapping the Furnace or the Casting of the Statue of Louis XIV., in the Studio of M. Girardon.



Side view of Mould, bound with iron bands, for casting Statue of Louis XIV. Also top view of same showing the of jets and vents.

pers for the higher certificate were very od. The failures mainly resulted from in-curate transposition, wrong analysis of keys, d from the misunderstanding of syncopa-n.

In Harmony, he considers that the teaching d study of the candidates for the elementary rtificate has been satisfactory. The errors ere mainly in the restlessness of the parts dded to figured basses, and in the ungram-atical part-writing. The result of the ex-mination for the higher certificates in Harmony e examiner considers satisfactory. Many of e papers were admirably worked, showing kill and fluency in part-writing. The faults ere lack of knowledge of the treatment of hromatic chords, ungrammatical part-writing, ability to write simple modulations, and want f judgment in harmonising a given melody.

The increase of numbers in this year's xaminations has been distributed over early all the subjects, every subject howing an increase except Spanish and talian, in each of which there is a trifling alling off. Book-keeping is still the most opular subject, showing 3,008 candidates—n increase of 660 on last year. Shorthand is he second largest, with 1,272 candidates—an ncrease of 242. It is satisfactory to note a onsiderable proportionate increase in Arith-netic; last year there were only 139, now here are 239. Larger numbers have entered or all the language examinations except hose above mentioned, English showing an ncrease of 29, French of 80, German of 1, Portuguese of 9. In Italian there is a ecrease of 5, in Spanish one of 11. This ear, again, no candidates have presented hemselves in the four less commonly used anguages — Russian, Danish, Chinese, and Japanese. Domestic Economy shows an in-rease of 103, Rudiments of Music one of 62, Harmony of 47. Both the new subjects attracted candidates — Economics 21, and Précis-writing 18.

In the Book-keeping examination an unfortunate error was made in setting the paper. The error, though it was one which could not be detected except by actually working the paper, was of such a character as to vitiate the results of the examination, since it caused candidates to waste a considerable amount of time, and in some cases to abandon the attempt to work the paper correctly, and the Council felt that the only way of dealing with the matter was to give candidates tbe opportunity of a second paper. A supplementary examination was accordingly held on the 21st of April, and of this nearly all the candidates availed themselves. The original papers of those who could not come up for the second examination were submitted to the examiner, and full allowance was made for the mistake.

The examiner reports that the characteristic of the papers was a good average mediocrity. Though the number and proportion of students falling short of the very modest requirements for a third-class certificate had slightly increased, there were fewer absolutely unprepared candidates. The per-centage of first-class is very slighly below the average for the previous ten years. But there were fewer really excellent papers approximating to full marks than has been usual. Some of the papers were models of concentration, arrangement, and accuracy.

The examiner in Shorthand states that the working of the paper on this subject was on the whole fairly satisfactory. There is a large proportion of failures, but a distinct improvement in the first-class papers, in which last year there was a serious falling off. This year not only are these papers better in quality, but their proportion to the total number of papers worked is considerably larger than usual.

With regard to Type-writing, the examiner repeats the remark made in former years, that a higher educational standard for the pupils should be insisted upon before they are sent in to the examination. Some of the best papers in the first-class are extremely good, and in both the higher grades a large number of the replies asked for to a business letter were surprisingly good, showing interest and appreciation of the subject, as well as a knowledge of technical phraseology. Most of the candidates seem not to have given sufficient time to the dictation paper, which, in many cases, shows marks of hurry.

With regard to the new subject of Précis-writing, the examiner remarks that "On the whole, the abstract on India was fairly well done, but the same can hardly be said of the 'Memorandum or Précis.' The candidates were too much inclined to neglect the direction that this memorandum or précis should not be drawn up, letter by letter; consequently the narrative is, in many cases, obscure and confused, and the main questions at issue are frequently lost sight of. Candidates would, in most cases, probably do well, after making the Abstract, and before commencing the Précis, to ask themselves what is the really important point upon which the correspondence turns;

and they might, with advantage, begin the Précis by indicating briefly one, or at least two, of the principal questions which it tends to elucidate."

Of the other new subject, Economics, the examiner considers the answers to the elementary questions showed evidence of good teaching, supplemented with careful study. "In the more advanced questions also a fair number of candidates obtained a sufficiently high per-centage of marks to place them in the first-class. The questions on banking and taxation were not very well answered, and I was much disappointed with the manner in which the historical questions were dealt with. The answers of the candidates, with one or two exceptions, showed only a meagre and inaccurate acquaintance with the economic history of England. With these qualifications, however, the papers were on the whole very satisfactory."

The examiner in English remarks on the bad preparation shown by certain of the candidates, and desires to call the attention of teachers to the fact that they should not send up from any centre a number of candidates so ill-prepared that only a small proportion of them contrive to secure a place in the third-class.

The examiner in Arithmetic, while noticing that the number of candidates shows a large increase, points out that the per-centage of failures have been raised by the advent of a considerable number of quite inadequately prepared candidates. There are fewer first-class papers than usual, and the style of the best are not so good as that of the best papers in former years.

The examiner in Geography considers that the proportion of better-class candidates compares favourably with former years, and thinks that more care has been taken in preparing for the examination, though sufficient attention has not been paid to sources of information outside general text-books.

The examiner in French reports that the general character of the work is very satisfactory. He considers that the papers show an improved sense of the necessity for earnest study in a language which, though sufficiently easy in its elements, is really an extremely difficult one to master thoroughly.

The examiner in German speaks favourably of the general result of the examination in this subject, though want of efficient preparation is still noticeable in many cases.

The examiner in Portuguese considers that the results of this examination show an improvement on former years, and give signs o more than usual careful preparation.

The Italian papers, in the opinion of the ex aminer, show a good general standard, thoug no special excellence, or any great short comings. He thinks that more attentio should be paid generally to the study of th grammar of the language.

In consequence of the large increase o numbers in certain of the subjects, the Counci thought it well to add to the number of medal offered to first-class candidates, and thi alteration was brought into effect for th current year's examinations. In previou years one medal has been presented in ever subject, two when there were 100 candidate in any subject, with an additional medal i those subjects for which the number of candidates exceed 500. An additional medal ha now been added for every 500 candidates afte the first 500.

The Council have again to acknowledge the assistance they have received from many o the City Companies. The Clothworkers offered special prizes for certain of the language subjects, and the following Companies subscribed to the special Prize Fund, out of which money prizes are provided for others of the subjects*:—Goldsmiths, Merchant Taylors, Skinners, Leathersellers, and Salters.

XVI.—PRACTICAL EXAMINATIONS IN MUSIC, 1895.

The results of last year's practical examinations in Music were not issued in time for the results to be included in the last Report of the Council. Though they appeared in the *Journal*,† it may be as well to repeat them here. There were 390 candidates, an increase of 11 over 1894, of whom 59 failed to pass: 17 candidates took up two subjects, so that there were 407 examinations; 90 first-class certificates were awarded, and 239 second-class. Fifteen medals were awarded to those candidates who obtained full marks. The following were the subjects:—Piano, singing, violin, organ, harp, violoncello, and cornet.

Mr. John Farmer, of Balliol College, Oxford, and Director of the Harrow Music School, acted as Examiner, and Mr. Ernest Walker, M.A., Mus. Bac., as Assistant-Examiner.

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* The Clothworkers' Company prizes are offered in Italian, Spanish, and Portuguese; the other prizes in English, Commercial Geography, French, and German.

† See *Journal*, 5th July, 1895, vol. xliii. p. 745.

XVII.—PRACTICAL EXAMINATIONS IN MUSIC, 1896.

The Practical Examinations in Music for is year commenced on the 22nd inst., and ill not be concluded until the 1st of July, so at it is impossible to include in the present port any account of the results.

Some modifications have been introduced in e system of examination for the present year. andidates are asked to select for themselves hich of four standards they choose to be amined in. Standard I. is easy, Standard . moderately difficult, Standard III. difficult, and Standard IV. very difficult. For ich standard a list of music is given, and a election from this list is sent to the candidates six weeks previous to the examination. andidates are expected to play or sing pieces om the selected list, as well as to play a iece, or a portion of a piece, at sight.

It is thought that by these alterations a etter test of the candidates' ability will be rovided, and it is hoped that the division into andards may attract a larger proportion of udents of a higher class than formerly have ntered for the Society's examinations.

It might have been expected that the alteration would have seriously reduced the number f candidates entering, but this has not been ie case. For the present year 377 candidates have entered, a decrease of only 13 on ie 390 candidates entered last year.

A summary of the results will be published n the *Journal* as soon as it can be prepared.

XVIII.—CONFERENCE ON TECHNICAL EDUCATION.

It was stated in the last Report of the ouncil that a Conference on Technical Education had been held, and that a resolution ad been passed thereat, recommending that representative Committee should be appointed o consider the question of examination in subjects not included in the schemes of the Science nd Art Department, the City and Guilds of ondon Institute, and the Society of Arts. Vith the view of carrying this resolution into ffect, the Council invited the County Councils, nd other educational bodies, to nominate epresentatives on the Committee. Most of hem consented, and a large and influential ommittee was formed. It met on the 5th of ecember, 1895, Sir John Donnelly, Chairman f the Council, in the chair. The general eeling of the Committee appeared to be dverse to the establishment of any central organisation, and eventually the Committee adjourned without coming to any definite decision.*

XIX.—MEMORIAL TABLETS.

Since the last announcement, Memorial Tablets have been erected on the house at Hampstead occupied for some time by the poet Keats, and on the house in Bentinck-street, in which the historian Gibbon lived for many years.

The following is a complete list of the tablets which have been set up:—

James Barry	36, Castle-street, Oxford-st.
Robert Browning	19, Warwick-crescent, Paddington.
Edmund Burke	37, Gerrard-street, Soho.
Lord Byron	16, Holles-street.
George Canning	37, Conduit-street.
George Cruikshank	263, Hampstead-road.
Madame D'Arblay (Fanny Burney)	11, Bolton-street, Piccadilly.
Charles Dickens	Furnival's-inn.
John Dryden	43, Gerrard-street.
Michael Faraday	2, Blandford-street, Portman-square.
John Flaxman	7, Buckingham-street, Fitzroy-square.
Benjamin Franklin	7, Craven-street, Strand.
Thomas Gainsborough	Schomberg-house (now part of the War-office), Pall-mall.
David Garrick	5, Adelphi terrace.
Edward Gibbon	7, Bentinck-street.
George Frederick Handel	25, Brook-street.
Sir Rowland Hill	Bertram-house, Hampstead.
William Hogarth	30, Leicester-square.
John Keats	Lawnbank, Hampstead.
Samuel Johnson	17, Gough-square, Fleet-street
Napoleon III.	3A, King-street, St. James's.
Lord Nelson	147, New Bond-street.
Sir Isaac Newton	35, St. Martin's-street.
Peter the Great	15, Buckingham-st., Strand.
Sir Joshua Reynolds	47, Leicester-square.
Richard Brinsley Sheridan	14, Savile-row.
Mrs. Siddons	27, Upper Baker-street.
Wm. Makepeace Thackeray	Kensington Palace-green.
John Thurloe	24, Old-square, Lincoln's-inn.
Sir Robert Walpole	5, Arlington-street.

The Council will be glad to receive suggestions from members of the Society or others who know of houses once the residences of celebrated persons, the owners of which would permit the erection of tablets.

XX.—HISTORY OF THE SOCIETY.

Some progress has been made with the preparation of a History of the Society, in accordance with the suggestion made by the Chairman of Council, in his address at the opening of the Session, in 1894, which was referred to at the last Annual General Meeting. The matter has been placed in the hands of the Secretary and Assistant-Secretary of the Society.

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* A full report of the proceedings appeared in the *Journal* for 20th December, 1895, vol. xliv. p. 65.

XXI.—CONVERSAZIONE.

The Annual Conversazione of the Society was held on the 17th June, by permission of the Lords of the Committee of Council on Education, at the South Kensington Museum. The usual arrangements for the entertainment of visitors were made, and on this, as on many previous occasions, the Society are much indebted to the care and attention which was shown by the principal officials and the staff of the Museum in making the necessary preparations. The numbers attending were 1,720.

XXII.—HOWARD LECTURES.

The Council have arranged for a course of lectures to be given under the Howard Trust next Session. This bequest was left to the Society in 1872 for a periodical award of a prize for an essay on steam, or other motive power, or an invention connected therewith. Two previous courses of lectures have been delivered under this Trust, one by Dr. Anderson, on "The Conversion of Heat into Useful Work," and the other by Professor Cawthorne Unwin, on "The Development and Transmission of Power from Central Stations." Both of these courses have been published in the form of text-books.

The lectures next Session will be delivered by Professor Ewing, F.R.S. The precise subject will be announced later on in the *Journal*.

XXIII.—EAST-END INDUSTRIAL EXHIBITION.

The promoters of the Exhibition now being held at the People's Palace, Mile-end, applied to the Society for assistance in providing prizes for workmen's exhibits. A certain sum of money having been accumulated under the North London Exhibition Trust Fund, the Council thought that they could not make a more suitable use of a portion of this money than by placing £20 and four Bronze Medals at the disposal of the Committee of the People's Palace Exhibition, to be devoted by them for special prizes.

XXIV.—CHADWICK TRUST.

The late Sir Edwin Chadwick left funds amounting to about £33,000 for the purpose of establishing a Trust for the promotion of sanitary science. Sir Benjamin Richardson was nominated Chairman of the Trust, and four other gentlemen were appointed trustees. addition to these there are two trustees, one be appointed by the Council of the Society Arts and the other by the Council of the Roy Institution.

The Council of the Society, in response to application made to them by the chairma undertook to make the appointment, and nom nated Sir Douglas Galton as their represent tive for a period of five years.

The trustees are directed to present eve five years a shield or medal of the value £100 to a sanitary authority which has show a material reduction of the death-rate in i district; the sum of £100 and a medal to officer who has specially assisted in promotin the health of the men in the navy or the army also a like prize to a teacher in an industri school who has specially assisted in promotin the mental and physical well-being of t children in his school. In addition to thes the trustees are empowered to establish Pr fessorships of Sanitary Science, to arrange f lectures in sanitary science, and to give prize for the study of sanitary science.

XXV.—HORSELESS CARRIAGES.

The attention of the Council having bee drawn by the Self-Propelled Traffic Asso ciation to certain of the provisions in th Locomotives on Highways Bill now befor Parliament, the Council prepared a petitio to Parliament, praying that the Bill might b so altered as to permit of vehicles of a slightl greater weight than that contemplated in th original draft of the Bill. The alteratio desired was made in the House of Lords.

XXVI.—ADDRESS TO LORD KELVIN.

Arrangements having been made to celebrat the Jubilee of Lord Kelvin's tenure of the Professorship of Natural Philosophy at Glasgow, the Council invited Sir Frederick Abel t represent them on this occasion, and entrusted him with a congratulatory Address* to be presented to Lord Kelvin.

XXVII.—NEW COUNCIL.

In accordance with the Bye-laws, the Council have submitted to the meeting the Balloting List for the election of new members of Council. The Vice-Presidents retiring by seniority are Mr. Carteighe, Sir John Donnelly, Sir Villiers Lister, and Sir Albert Rollit. Mr. Cobb also tires with the view to his being proposed ; Treasurer, in place of Sir Frederick ramwell. To fill the above vacancies, the ouncil propose as Vice-Presidents—Captain bney, Sir Frederick Bramwell, Sir George rdwood, Viscount Cross, and the Right on. George N. Curzon. Lord Cross and Mr. urzon have never before served on the ouncil. Sir George Birdwood retired last ear, after a continuous service of considerable ngth.

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* The text of this Address will be found in the *Journal* for June 19, 1896 (p. 653).

The following four Ordinary Members of ouncil retire :—Captain Abney, Sir George hubb, Francis Elgar, and Professor Le Neve oster. The following are proposed to fill heir places :—Joseph G. Gordon, Henry raham Harris, James Sewell Neville, and rofessor J. Millar Thomson. Mr. Gordon ead a very interesting paper on "The Mannesann Process for making Seamless Tubes" in 890, and for this he received the Society's ilver medal. In 1889, Mr. H. G. Harris ave a valuable course of Cantor lectures on Heat Engines other than Steam." Professor homson acted for several years as Secretary f the Chemical and Physical Section of the ociety until its disestablishment in 1887. Ie has given us three courses of Cantor ectures and two courses of Juvenile lectures. Ir. Neville may be known to many of the embers as a frequent attendant at the ociety's meetings.

XXVIII.—OBITUARY.

During the past year the Council have had o regret the loss of a Member, and a very listinguished Member, of their own body—ord Leighton. Among his numerous avocaions Lord Leighton always found time for any art of the Society's work in which his wide rtistic experience could be of service. He vas always consulted in such matters by the Council, and never failed to afford judicious advice. When the Council was constituted a Royal Commission for the Chicago Exhibition, hey asked Lord Leighton to act as Chairman of the Fine Arts Committee, and to his labours n this capacity was certainly due the very fine collection of English pictures which was sent o the Exhibition.

Sir Henry Ponsonby, who died in November ast, had only a short time before retired from he Vice-Presidency of the Council. He was a frequent attendant at its meetings, and took much interest in the Society's work.

Sir Edward Harland also served as a Vice-President for the Session, 1892-3. Sir Thomas Wade on several occasions took an active part in the work of the Society, and in 1891, he read a paper on China, for which he received the Society's Silver Medal. Mr. H. D. Pochin was a member of the Society from 1868, and in 1852 he subscribed £50 towards establishing a scheme for the erection of Memorial Tablets in London.

The Rev. Horace Waller was a very active member of the Society's African Section, before which he read papers on several occasions. Mr. Abernethy, the eminent civil engineer, was a member of the Society of nearly forty years' standing. The Rev. William Rogers was also an old member of the Society. In 1865 and 1869 he was a Member of Council, and he served as a Vice-President in 1870-1875.

Sir Julian Goldsmid, though a member of the Society since 1879, never took any very active part in its work. Mr. Margary and Mr. Greener were both engineers, associated, in the earlier days of railway making, the former with the Great Western, the latter with telegraphy.

Obituary notices of all the above have appeared in the Society's *Journal.*

XXIX.—FINANCE.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

The CHAIRMAN moved the adoption of the report, and Mr. FRANCIS COBB seconded the motion.

The adoption of the report was then agreed to.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

Vice-Presidents.

H.R.H. the Duke of Saxe-Coburg and Gotha, K.G.
H.R.H. the Duke of York, K.G.
Sir Frederick Abel, Bart., K.C.B., D.C.L , D.Sc., F.R.S.
Duke of Abercorn, K.G., C.B.
Captain W. de W. Abney, C.B., F.R.S.
W. Anderson, C.B., D.C.L., F.R.S.
The Attorney-General, G.C.M.G., Q.C., M.P.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
Sir Edward Birkbeck, Bart.
Sir Courtney Boyle, K.C.B.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
Right Hon. Viscount Cross, G.C.B.
Right Hon. George N. Curzon, M.P.
Hon. Sir Charles W. Fremantle, K.C.B.
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
Lord Halsbury.
Lord Kelvin, F.R.S.
Sir Charles Malcolm Kennedy, K.C.M.G., C.B.
Sir Stuart Knill, Bart., Alderman.
William Henry Preece, C.B., F.R.S.
Prof. William Chandler Roberts-Austen, C.B., F.R.S.
Earl of Rosebery, K.G., K.T.
Sir Saul Samuel, K.C.M.G., C.B.

Ordinary Members of Council.

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
John Wolfe Barry, C.B., F.R.S.
Lord Belhaven and Stenton.
George Ledgard Bristow.
Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.
R. Brudenell Carter, F.R.C.S.
Joseph G. Gordon.
Henry Graham Harris.
James Sewell Neville.
Sir Westby B. Perceval, K.C.M.G.
Alexander Siemens.
Professor John Millar Thomson.

Treasurers.

B. Francis Cobb.
Sir Owen Roberts, M.A., D.C.L., F.S.A.

Secretary.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN, seconded by Mr. ALEXANDER SIEMENS, a vote of thanks was passed to the Scrutineers, which was carried unanimously.

The CHAIRMAN moved a vote of thanks to the officers of the Society, which was seconded by Mr. F. W. PRICE, supported by Mr. MARTIN WOOD, and carried unanimously,

The SECRETARY returned thanks to the Society for this expression of confidence in himself, and in the other officers of the Society.

Sir FREDERICK BRAMWELL, Bart., D.C. F.R.S., proposed a cordial vote of thanks to Chairman for his great services as Chairman of Council, an office which he had held for two yea to the satisfaction of all those over whom he presid

The resolution was seconded by Sir CHARI FREMANTLE, K.C.B., and carried unanimously.

The CHAIRMAN acknowledged the vote of than and the meeting then adjourned.

Miscellaneous.

COMMERCIAL FEDERATION OF THE EMPIRE.

Mr. J. G. Colmer's, C.M.G., prize essay on t Commercial Federation of the Empire has be published in *The Statist*, and the following is synopsis of the essay.

The scheme may be divided into four parts:—

1. The granting of preferential treatment Colonial and Indian products in the Unit Kingdom. 2. Preferential treatment of Briti products in the Colonies and India. 3. The add tional revenue so derived to form a fund, if the Moth Country and the Colonies and India agree, with view to improve and supplement the defences of th Empire outside the United Kingdom. 4. Th formation of a Colonial Council to give the Coloni a greater voice in Imperial affairs, and to provide f the administration of the fund.

1. It is suggested that in the United Kingdo small specific duties should be placed on certai enumerated articles, about twenty in number, whe imported from foreign countries—similar impor from the Colonies and India to remain duty free, at present. These duties, it is anticipated, woul realise about £2,700,000.

The enumerated articles are live animals, meat cheese, butter, wheat, flour, hemp, and other fibre ivory, undressed leather, sugar, unrefined and re fined, wool, tallow, seal skins, fish oil, logwood mahogany, and nuts and kernels for oil.

It is also proposed to reduce by one-half th existing duties on imports from the Colonies an India of cocoa, coffee, and tea, the duties on th foreign imports of those articles to remain as a present. This re-arrangement of the existing tariff, with a reduction of 5 per cent. in the duties o tobacco from all countries, would mean a decreas in the revenue to the extent of about £2,000,000. I will be seen, therefore, that the scheme involves, roughly speaking, a net increase in the revenue o the United Kingdom of about £700,000.

It is urged that an increase in price is not likely to result from the placing of duties on foreign imports of the enumerated articles, at any rate to the extent he proposed duties. In every case there would be a considerable importation of the different ımodities from the Colonies and India. As they ıld remain duty free, the supplies coming from ıin the Empire would dominate the market, and, ı the foreign competition, have a tendency to vent the increase in prices which perhaps might ow if duties were placed upon such imports from countries.

. As the fiscal systems in the Colonies and India so varied, and the nature of their trade exchanges lifferent, it has apparently been found difficult to ke any proposal giving preferential treatment of a form character to British imports in those markets, eturn for the concessions suggested on the part the United Kingdom. It is, therefore, recomnded in the essay that the Mother Country should e the initiative in the matter, inform the Colonies l India what advantages the United Kingdom is pared to offer to the imports of the articles ımerated from within the Empire, and ask what ıcessions of a preferential character they would be pared to extend to imports from the United ngdom over imports from foreign countries. It elieved that correspondence of this nature would ve the way for an Imperial conference, at which details of the proposals could be discussed, and finite arrangements agreed upon, by which in every rt of the Empire there would be a preferential treatnt, on a moderate scale, for inter-Imperial trade.

3. Assuming that the Colonies were prepared to ınt preferential treatment to British trade (upon ich no doubt appears to exist, in view of the resoions of the Ottawa Conference), assuming also that lia was ready to follow their example, and that y rearranged their tariffs in favour of British trade a manner satisfactory to the United Kingdom; d that the formation of a fund for defence purposes s agreed upon as part of the scheme, it is fair to ppose that the Colonies and India would be able to ntribute, as partly or entirely the outcome of their eferential treatment of British imports, according their local circumstances, a sum equal in the aggre-te to the net amount of the additional revenue 700,000) to be raised in the United Kingdom. In e of the appendixes of the essay a suggestion for e apportiontment of the £700,000 among the lonies and India is offered. This would provide a nd of nearly £1,500,000 per annum, the joint conbution of the Colonies and India and the United ingdom, which it is suggested could be used to pplement and improve the existing defences, inding graving docks and coaling stations, in the tlying parts of the empire. Among other things e maintenance of guard-ships in the leading ports the empire is proposed. These vessels would be eful not only for harbour defence, but in connection ith the training of naval militia, which it is believed uld readily be formed in the leading martime ports the Empire. This force would not only be valuable cally, but would be available for drafting on Her Majesty's ships that might be operating in the neighbourhood of the Colonies in time of war.

4. In order to give the Colonies a larger voice in the affairs of the Empire than they now have, and to enable them to participate in the administration of the proposed fund for defence, the formation of a Colonial Council is suggested. It would consist of the Secretaries of State for the Colonies, Foreign Affairs, India, and War, the First Lord of the Admiralty, and the Chancellor of the Exchequer, the Colonial Secretary being president. The High Commissioner for Canada and the Agents-General of the self-governing Colonies—or such persons as the Colonies might appoint—would be members of the Council. It would be, as its name implies, a Council in which the Colonies would have a voice through their representatives in regard to any matters arising out of the preferential trade arrangements, and upon all other subjects in which the Colonies they represented had the right to consult, or to be consulted by the Imperial Government.

Retaliation on the part of foreign countries is not anticipated as the result of the adoption of the scheme, because their import duties are now as high, generally speaking, as they can be made, and any increase would react on the countries themselves. Besides, with the Imperial Customs Union in existence, a policy of retaliation would hardly be lightly undertaken.

The following are some of the advantages which it is claimed would be derived by the Mother Country, on the one hand, and the Colonies and possessions on the other, from the adoption of a scheme of commercial federation. It would bring the Mother Country into closer union with the Colonies. By giving preferential treatment, on a moderate scale, to British trade within the limits of the Empire, the bond of unity would be material as well as sentimental. By such preference the doctrines of free trade that prevail in the United Kingdom would not be seriously endangered, and freer trade than at present would be made possible within the Empire. On the other hand, the British manufacturer would retain the control of the rapidly increasing Colonial markets. There would be a unity for the defence of the outlying parts of the Empire, and a Colonial Council for mutual consultation on matters of general interest. Greater attention than ever would be attracted to the Colonies. Emigration would flow in larger number to their shores, and increase the demand for British goods. The investment of capital in the Colonies would be encouraged, and their powers of producrion be so increased that the United Kingdom would year by year depend less upon foreign sources for her food supplies.

Attached to the essay are several statistical appendixes, illustrating the commercial affairs of the Empire, and showing that, relatively speaking, the trade of the United Kingdom with the Colonies has been increasing in a greater ratio than the trade with the other parts of the world.

LECTURES AT THE BERLIN EXHIBITION.

Among the lectures announced for delivery in connection with the Berlin Industrial Exhibition during the months of July, August, and September, are the following:—

July 2, "The Hygiene of Drinking-water," by Prof. Gärtner, of Jena. July 3, "Low Temperatures, their production and application," by Prof. Raoul Pictet. July 10, "The Development of Piano Construction," by Dr. C. Krebs. July 14, "Flour and its Adulteration," by Prof. Wittmack. July 16, "Weather Forecasts," by Prof. van Bebber, of Hamburg. July 17, "Perfumes, especially those made artificially," by Prof. Tiemann. July 18, "The Technics of Art Smithing," by Prof. Wiese, of Hanau. July 28, "Mountain Railways worked by Ropes," by Prof. Reuleaux. July 30, "The Sewerage of small and moderate-sized Towns," by Ingenieur E. Herzberg.

August 1, "The Technical Application of Rare Elements," by Prof. Winckler, of Freibourg. Aug. 5, "The Plants of East Africa, with special reference to those that may be utilised," by Prof. Volkens. Aug. 6, "The Art of Working Leather, now and formerly," by Dr. Vollbehr. Aug. 7, "Tapestry, with reference to its History, Art, Importance, and Technics," by Dr. von Schorn, of Heidelberg. Aug. 8, "Decorative Illumination," by the Kgl. Regierungsbaumeister Jaffé, Berlin. Aug. 10, "The Warming by Gas of Dwellings," by Herr Friedrich Siemens, of Dresden. Aug. 13, "Stains, and their Durability," by Director Spennrath, of Aachen. Aug. 18, "Carpets, and their Manufacture," by Regierungsrath Max Speer. Aug. 19, "The Hygiene of Work," by Prof. Kräpelin, of Heidelburg. Aug. 20, "The Present Technics of Spinning," by Regierungsrath Hartig. Aug. 21, "Rational Fish Culture and its Economical Importance," by Director Haack, of Hüningen. Aug. 22, "Porcelain, and its Decoration," by Dr. Heinecke.

September 7, "River Pollution," by Dr. Ohlmüller. Sept. 8, "The Utilisation of Animal—especially Fish—Refuse," by Dr. Weigelt. Sept. 12, "The Art of Bread-baking," by Dr. Kusserow. Sept. 30, "Patent, Sample, and Trade Mark Protection," by Dr. Oskar Schanze, of Dresden.

Correspondence.

CACAO IN MEXICO.

In the interesting report by Sir Henry Dering on the "Cultivation of Cacao in Mexico," reproduced in the *Journal of the Society of Arts* for June 19, p. 659, it is stated "The species of cacao tree most cultivated in Mexico are—Cacao, or *Theobroma ovalifolia*, *T. bicolor*, *T. augustifolia*. There are other kinds known, generally found growing wild, which come under the head of the Guazuma guacima, *Guazuma polybotrya* being the princ species." The latter part of this extract puzzle a good deal, and we addressed a letter on the sub to the Foreign-office, and asked for specim These having arrived, we found that they belon entirely to *Theobroma bicolor*, and had no rela whatever to the genus Guazuma, as stated in report. The point is, that there are no other ki of cacao growing wild which come under *Guazu polybotrya*, or any species allied to it. As infor tion of this kind ultimately finds its way into te books, and becomes incorporated into the literat of cacao, the Director thought it desirable to di your attention to it, in order that the readers of *Journal* may be placed in possession of the furt facts recently obtained from Mexico.

D. MORRIS, Assistant Direct

Kew, 20th June, 1896.

General Notes.

BRUSSELS EXHIBITION, 1897.—The regulati relating to foreign goods sent to this Exhibition, sa tioned by the King, have been issued and publish in the *Moniteur Belge* for May 24, 1896. Forei goods intended for the Universal Exhibition will received provisionally, free of custom duties, and exportation will be in accordance with the conditic settled by the Minister of Finances. Goods admitt free for purposes of exhibition can be sold after t closure of the Exhibition, on condition that t custom duties are paid.

GUATEMALA EXHIBITION, 1897.—Referring the notice of the forthcoming Central Americ Exhibition in the number of the *Journal* for Ju 5th (see *ante*, p. 619), information has been receiv from the Foreign-office, through the Science a Art Department, to the effect that Article 60 the General Regulations of the Exhibition, whi deprived foreign exhibitors of any claim to diplomat intervention in all matters relating to the Exhibitio has been withdrawn by a Presidential Decree of t 2nd inst.

PARIS DRAMATIC AND MUSICAL EXHIBITION.—An Exhibition of the Stage and Music will be hel at the Palais de l'Industrie, Paris, from the 25th Jul to 25th November. The classification of the content of the Exhibition will be as follows:—Group 1 Musical Instruments; 2, Architecture of the Theatre 3(a), Graphic Industries; 3(b), Photography; 4 Costume; 5, Scenery and Furniture of the Stage 6, Lighting and Heating; 7(a), Chemical Industrie and Hygiene; 7(b), Perfumery; 8, Metal Industry 9, Leather, Ivory, and Indiarubber Objects; 10 Ceramics. A communication from Baron de Courcel French Ambassador in London, respecting the Exhibition has been received by the Foreign Office, and communicated to the Science and Art Department.

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FRIDAY, JULY 3, 1896.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the othergill prize of £25 and a silver medal for paper on "The Best Means of Effectually reventing the Leakage of Current to Earth in lectrical Installations from Generating Heat nd Setting Buildings on Fire." The paper hould consist of about eight thousand words, nd be written with a view to being read nd discussed at an ordinary meeting of the ociety.

Papers submitted for the prize must be sent the Secretary on or before 1st of October, 896. Each paper must be typewritten, and ear a motto, the name of the writer being nclosed in a sealed envelope with a similar otto. The judges will be appointed by the ouncil.

The Council reserve the right of withholding e prize or of awarding a smaller prize or maller prizes, if in the opinion of the judges o essay deserving the full award is sent in.

RIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are repared to award, under the terms of the enjamin Shaw Trust, a Gold Medal, or a rize of £20.

The medal, under the conditions laid down y the testator, is to be given "For any discovery, invention, or newly-devised method for bviating or materially diminishing any risk to ife, limb, or health, incidental to any industrial occupation, and not previously capable of eing so obviated or diminished by any known nd practically available means."

Intending competitors shall send in descripions of their inventions not later than the 1st December, 1896, to the Secretary of the ociety of Arts, Adelphi, London, W.C.

The Judges will be appointed by the ouncil.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

ON GOLD MINING IN RHODESIA, BRITISH SOUTH AFRICA.

By William Fischer Wilkinson,
F.G.S.; Assoc.M.Inst C.E.

The information obtainable on the mineral resources of the British South African territory is so small, and the public interest in its future so great, that a paper on my experiences during a visit of two months' duration, at the latter end of 1895, may not be without some value at the present time. It is indeed remarkable, considering the enormous sums that have been subscribed to develop that country, that so little has been published on its mineral wealth.* It must, however, be remembered that the country is young, and that the difficulties of travelling are very great, so that few travellers, except for the purposes of sport, leave the main coach routes or have opportunities, such as I had, of visiting the best developed mines of the remoter goldfields.

It will, perhaps, be convenient if I commence by describing the best ways of reaching the country. There are three main routes: the Mafeking route, the Transvaal route, and the Beira route. The Mafeking route has the advantage of being entirely in British territory. Mafeking, in British Bechuanaland, is the present terminus of the Cape Railway, and this part of the journey takes two days. From Mafeking to Buluwayo, the capital of Matabeleland, there is a coach service, the journey taking some six days. This is the main trade route at present. A second route is by way of the Transvaal, using the railway as far as Pretoria, and thence on by coach, *viâ* Pietersburg and Fort Tuli. The journey takes much the same time as the Mafeking route, but, in the opinion of those who have tried both routes, is much the least fatiguing. The traveller gets a few hours' sleep every night, which is not the case on the Mafeking road. The third or East Coast route is *viâ* Beira, thence by boat to Fontesville, by train to Chimoio, and by coach to Salisbury and Buluwayo. Although the most convenient for Mashonaland, it has its disadvantages. Beira is a very unhealthy port, and the difficulties of passing goods through Portuguese territory are very great; indeed, traders find it better to bring their goods into the country by the longer and more expensive Mafeking route.

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* Sixty of the best known Rhodesian companies have an aggregate nominal capital of £15,000,000 sterling.

It seems, however, probable that the railway will soon be extended on from Chimoio, in which case Beira will become more important than it is at present.

The ordinary traveller will find the best way of seeing the country is to make the round trip, entering by one of the southern routes, and leaving at Beira, or *vice versá*. There is a regular coach service between Mafeking, Buluwayo, Salisbury, and Chimoio; and the traveller will find hotels at these towns and at the principal mining camps.

The best season of the year to travel in is during the dry months, from July to November.

Those who can afford the time will find the pleasantest way of travelling, at all events in Matabeleland, is to have their own cart and team of mules. The cart should be fitted up with beds and cooking appliances, so that the traveller can stop where he likes on the road, and be independent of the trading stores or "hotels" for accommodation. The coaches are very often overcrowded, and the service is wretchedly managed. I have had some rough travelling experiences in Mexico and in Asia Minor, but I do not remember ever having had a rougher time than during my six days' coach journey from Pretoria to Buluwayo.

Turning now to the geographical position of the goldfields, it will be seen, from the map accompanying this paper, that they cover a large extent of country, stretching in a north-easterly direction, from Tati in the south-west to Mazoe, some 400 miles away in the north-east corner of Mashonaland. Those lying to the west of longitude 30° west belong more properly to Matabeleland, while those to the east are in Mashonaland, though the exact position of the boundary between these two districts is not quite clear. The goldfields all belong to one geological formation, namely, ancient metamorphic slates and schists, but are separated into distinct groups by intervening granite outcrops.

The following is a list of the principal goldfields with the names of some of the prominent mines :—

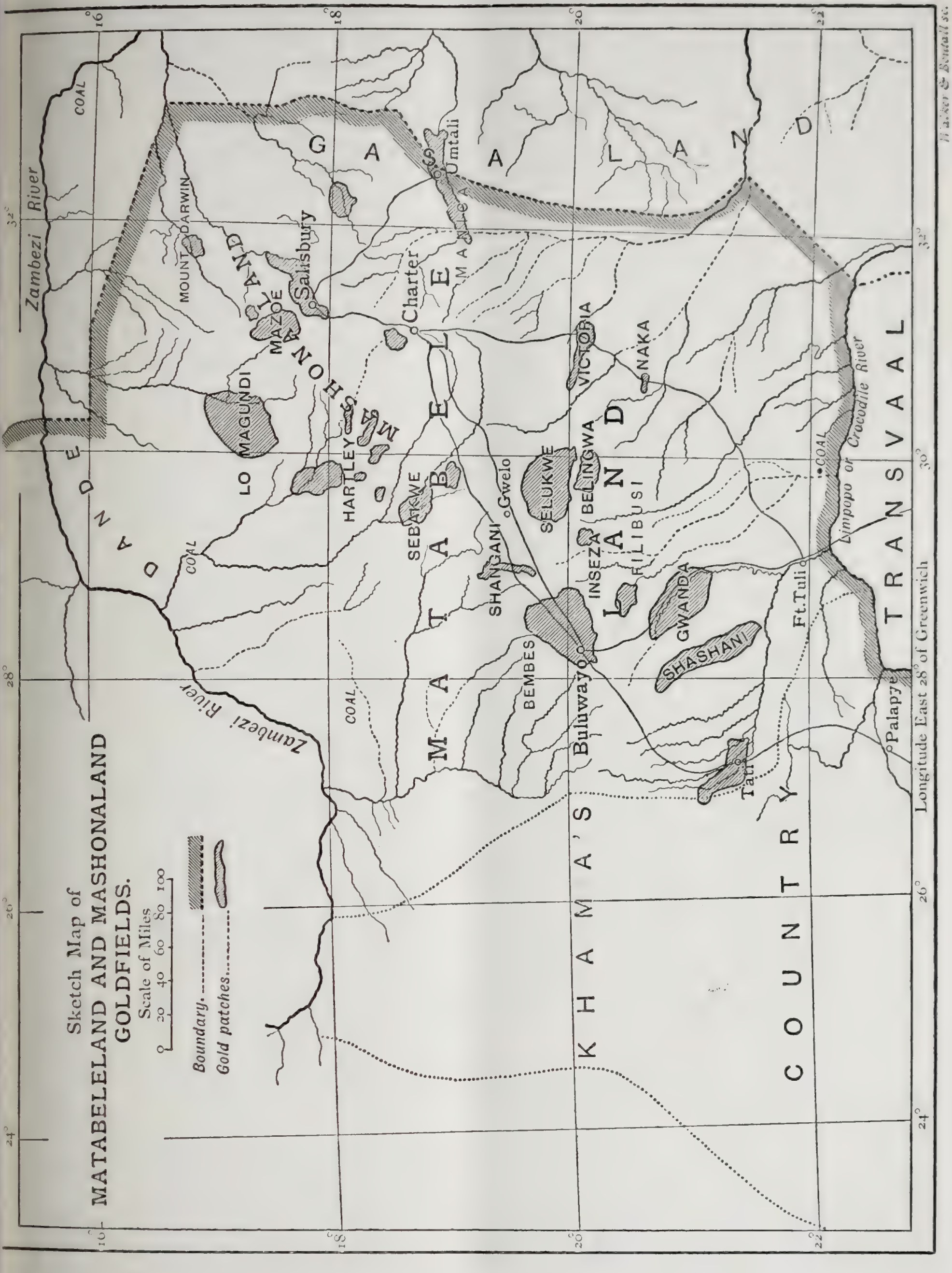
Matabeleland. — Buluwayo and Bembesi (Queen mine); Selukwe (Dunraven, Bonsor, Moonie, and Tevakwe mines); Belingwa (Wanderer's Rest); Gwanda; Tati (Monarch Reef); Filibusi; Sebakwe and Mavin (Phœnix and Globe); Shangani (Eagle mine); Inse (Nellie Reef mine, Pioneer).

Mashonaland.—Lo Magundi (Ayrshire Hartley (Inez); Mazoe; Salisbury (Salisbu Reef); Umtali and Manica; Victoria (Co paxi mine).

For the purposes of administration Rhode is divided up into magisterial districts follows: — A. Matabeleland — 1. Buluwa district, embracing Sebungo, Wankie, Bu Bulalema, Buluwayo, Belingwe, Gwand and Mangwe. 2. Gwelo district, embraci Majungo, Busi, and Gwelo. B. Mashonala —1. Lo Mogundi district. 2. Salisbury di trict, embracing Salisbury Mangwendi, Sal and Charter. 3. Hartley district. 4. Maz district. 5. Umtali district, embracing Umta Makoni, and Melsettier. 6. Victoria distric embracing Victoria, Intibi, and Tuli.

The geology of Matebeleland is not difficu to understand. The main structure consis of granite, upon which rests the metamorph schist and slate formation, containing t auriferous quartz reefs. The granite forms backbone to the country, stretching in a N. and S.W. direction, and forming the wate shed of the two great river systems, the Zan besi on the north, and the Limpopo on t south. The beds of schist and slate, belonging to an ancient sedimentary formation, hav been tilted up and metamorphosed into the present state by eruption of granite and othe eruptive rock. The area of the schist formation is often distinctly marked at surface b the red, clayey nature of the soil, whereas th granite weathers into a dry and sandy surface On the high veldt, the granite forms a rollin plain, cut out by "spruits" or water channels which are the head waters of the two grea river systems mentioned above. This hig land is studded with isolated granite hills o "kopjes," dotted about like small volcanoes and forming with their fantastic shapes a striking and characteristic feature of the configuration of the country. The schist formation, situated as it is, is favourable to th occurrence of gold. The rocks vary much in hardness, and, in some parts, especially in the Selukwe district, are much decomposed near the surface. The reefs have, as a rule, a similar strike to the schist formation, and consequently appear to be interbedded, but some reefs occur cutting across the strata with all the indications of being true fissure veins. The subject is one of great interest, as touching upon the permanency of the reefs in depth, and is one which it seems to me will be best settled by practical mining.

In the low country, towards the Zambesi in e north, and the Limpopo in the south, ounger formations are met with, and coal has been discovered some 200 miles north of Buluwayo in the Zambesi valley, and in the south about 50 miles east of Fort Tuli. Some ears must pass before these coalfields can e worked to advantage, owing to the absence f roads and railways.



Sketch Map of MATABELELAND AND MASHONALAND GOLDFIELDS.

In the eruptive rock class, besides granite, there also occurs greenstone (diatas and diorite?), especially in the neighbourhood of Buluwayo.

As already mentioned, it is in the schist formation that the gold quartz reefs occur. The quartz reefs, varying from a few inches to several feet in width, are numerous, and a large number of them are auriferous; indeed, the extensive area over which gold has been found appears to me one of the most striking arguments in favour of gold mining becoming a permanent industry. Some of the larger reefs have been traced for long distances, and have often one or more parallel reefs running near them. There are, of course, all qualities of quartz, from the white glassy quartz with crystals, which is usually barren, to the dull, almost opaque, white and blue quartz which, as far as my experience goes, is the best gold carrier. The quartz does not, as a rule, carry much pyrites, but probably in depth more will occur. Galena is frequently associated with the gold, but zinc-blende I have not seen. Pannings show that the gold is finely disseminated in the stone. I have seen reefs enclosed between good walls, notably the Tebakwe reef in the Selukwe district. As is usual with gold quartz reefs, the gold is not evenly distributed across the reef, in some mines occurring on the hanging wall, and at others on the footwall. The reefs have nearly all the same strike or direction, namely, true north and south, and usually dip to the west.

As regards the extent of mining, it is only natural, owing to the country having only been occupied some two years, that the mines of Matabeleland have not yet passed the development stage. The great majority of mining properties have only a 30-foot shaft, the amount necessary for an inspection certificate. I have examined a considerable number of these prospecting shafts, and a very unpleasant business it is, especially when the shaft is not a new one, for it is not at all an uncommon experience to find a snake, that has dropped down by mistake, ready to receive you at the bottom.

Some few mines, however, are being worked on a large scale. The most important of those which I visited are the Dunraven, Bonsor, Moonie, and Tebakwe mines, all in the Selukwe district, which is mountainous, and allows the reefs to be easily exposed by tunnels. To show what amount of development work has been done, I may mention that the "Moonie" mine has a shaft down 175 feet, and the length of payreef practically proved by a tunnel nearly holed to shaft is 240 feet. The reef appeared to me to average three feet in width. Another well developed mine is the "Bonsor," with several hundred feet of drive and a reef proved to water level some 300 fe in height. Another promising mine is t "Tebakwe," with a line of big old working 1,800 feet in length, of which at least 700 fe continuous are said to be pay shoot. A tunn along the reef has been driven under the o workings, and a strong healthy looking re has been exposed. The "backs" here a about 130 feet above adit. The Dunrav mine is also opening up well, and I unde stand that a stamp battery has been ordered

It will be seen, therefore, that there is mo than mere surface evidence available for for ing an opinion as to the possibilities of the re

An interesting feature of the gold mines the existence of numerous old workings throug out the country, proving that gold was di covered and eagerly sought for by some previo inabitants. It is not necessary to discuss he who these people were, or the time that th worked. Full information on this subject w be found in Mr. Theodore Bent's "T Ancient Cities of Mashonaland," and in M F. C. Selous' "Travel and Adventure South-East Africa." Suffice it to say her that the mining was carried on in a primiti manner, and that the reefs have seldom bee worked to a greater depth than 70 feet fro surface. These old workings form an excelle guide to the position of the best reefs, a have made prospecting in this country a ve simple matter; indeed, old workings have bee the sole object of search by prospectors, these always found a ready sale.

It should not, however, be assumed th only reefs with old workings upon them a auriferous. There are no doubt many aurifero reefs in the country (whether payable or n remains to be proved), which have not bee worked on by the ancients. The old mine appear to have only worked on those ree which showed a good surface outcrop, and is therefore probable that there are payab reefs without old workings, especially whe the country is flat and where there are no su face indications. The old workings have th form of an open cut or excavation along th outcrop of the reef. Many of these have durin the course of time been quite filled up with su face *débris*, but the larger old workings a still to be seen ten or twenty feet deep, grow over with vegetation, and having often larg trees growing out of them. The ancient mine were well acquainted with the fact that gold as a rule unequally distributed across a ree and have been careful to work out only th ost payable seam. Their method of breaking e stone was by fire-setting, and the quartz ust have been laboriously crushed with green-tone boulders, and the gold extracted by ashing in a pan. On the dump heaps the oorer quartz still remains to the present day, nd forms a guide as to the value of the stone eneath. As a rule the workings do not extend a greater depth than 70 feet below the sur-ce, but workings to a depth of 100 feet are nown. Various reasons have been given to xplain why the ancients did not mine deeper; t may have been on account of the natural difficulties of deep mining, such as bad air, water, harder rock and refractory quartz; or perhaps it was due to political causes or even o a superstitious dread of deep mining; whatever the real reason it appears to me to have been satisfactorily proved by recent development, that it is not due to an impoverishment of the reef—though this in some cases may have been the case—that deep mines are not found in this country. Mine development in a systematic modern manner to locate the direction and boundaries of a pay shoot played no part in the operations of the old mines, and a contraction of the reef, or a diminution in its value, appears to have soon discouraged them from further work. Naturally at the present time the mines that are being most actively developed, and which give the best promise of success, are those which have the most extensive old workings. As to the length of the workings, I have seen some in which payable quartz has been met with for several hundred feet; as a rule, however, the old workings are of small extent, consisting of trenches or circular pits, where old shafts existed, under 100 feet in length. I may mention also, from information given me by a friend with considerable experience in this country, that the size of the old workings at surface is not always a true guide to the amount of work done underground. Some small and insignificant old workings, when opened and cleaned out, have revealed extensive stopes.

Notice must be taken of the mining laws of Rhodesia, which have been the subject of much discussion and discontent, although they were specially drawn up by the British South Africa Company to meet the conditions of the country. A less elaborate and more intelligible code would have suited the country much better. Even the mining officials are often in difficulties in interpreting what the laws mean. As regards the facility for obtaining mineral property, no objection can well be raised. The British South Africa Company issue prospector's licenses at the low price of 1s., giving the owner the right to peg out a block of ten claims, 1,500 feet in length by 600 feet in width. Mining companies can, of course, amalgamate several blocks together by purchasing the requisite number of licenses. The law requires the holder of each ten claims to do 30 feet of work (shafts or drives) within four months of registration. This clause is open to the objection that the cost of 30 feet of work will vary considerably, according to the size of the shaft, the hardness of the ground, and the distance from a mining camp; it would have been fairer to have made the owner of a mining block do work valued at a certain sum—a system that is practised in the United States. It is not, however, a matter of much importance, and the clause was probably framed in this way to facilitate inspection. The law allows a company holding several claims to concentrate their development work, so that by putting down a shaft (say) 120 feet deep on one block, they can hold three other blocks upon which no work need be done.

A point in the law which seems likely to lead to a good deal of litigation is that which deals with the boundaries of a reef. The limits of mining are not fixed by surface boundaries, but a reef may be followed in all its "spurs, dips, and angles," an expression borrowed from the American code upon which the British South African code is based. It seems to me that the European plan of making the surface boundaries, produced vertically to an indefinite depth, the limit of mining rights is a much more satisfactory one.

The British South African mining laws require a certain annual amount of development work to be done after the first 30 feet; but this point is, I understand, at present in abeyance. It is strongly objected to by the numerous development companies formed to take up claims, with a view to flotation as subsidiary companies, as many of them are not in a position to do much actual mining work, and would undoubtedly have to abandon many of their claims if the British South Africa Company insisted on annual development.

I need scarcely point out that a 30 feet shaft does little to reduce the speculative element of mining. In my opinion it should be the part and purport of a *bona fide* development company to open out and expose one sufficient to warrant the erection of machinery.

The last point in the British South African mining law which I shall notice is that clause which confers on the Company 50 per cent. of the vendors' interest, when the development company is turned into a company to work the mine as a going concern, or, as the law expresses it, "for profit." The British South Africa Company thus becomes a large shareholder in every mining enterprise in the country, without making any direct contribution to its capital. It seems to me an interesting question, whether it is to the advantage of the country at large that the Government (*i.e.* the British South Africa Company) should have power to make money out of the mines before their success is established; for of course the vendors' shares can be sold before any output is made. The profits of the British South Africa Company ought rather to be derived from a royalty on the gold produced or on the dividends paid.

So far I have endeavoured to show that the country is auriferous, that gold-bearing quartz is found over a large extent of ground, and that mining has been carried on in the past by an ancient race on a considerable scale. It is now necessary to consider what chances the mines have of being commercially successful. In the first place it must be recognised that gold-mining in Rhodesia is quartz-reef mining, the chief characteristic of which is the irregularity of the occurrence of gold. Mining in this country must, therefore, be of a very speculative nature. It must be understood that no fair comparison can be made between this class of deposit and that of the Rand, where gold is found in conglomerate beds, the regularity of which, both as to value and as to quantity, allows very close and accurate calculations to be made. I mention this, as I have often seen it stated that Rhodesia is going to develop into a second Witwatersrand, and it is very likely that many people will be led to believe that the gold mines of Rhodesia are similar to the unique deposits of the Transvaal. If a comparison with other goldfields is necessary, the auriferous reefs of California, where the average yield is about 10 dwts. per ton, will probably be the best parallel to make. There is, however, one important difference between gold mining in the two countries, in that the alluvial deposits, which have been so productive in California, have not as yet been found in Rhodesia. Gold-quartz reefs are a class of deposit which requires considerable development to determine the extent and quality of the "shoots," or payable parts of the reef, before a fair opinion can be formed as to their value, and calculations based on a assays made from the outcrop or the bottom a small prospecting shaft, as are so often do are apt to be very misleading. Some mi have been sufficiently developed to enabl fair opinion to be made of the probable yie and an estimate of about 1 oz. per ton is ma of the best properties. I think it possible th with large mills a general average of 10 dw for the best mines will be obtained, though course by milling small quantities of ore higher grade could be treated.

I do not think that the conditions of mini are such as will prevent such mines from bei worked at a profit when the country is open up. At present, however, the difficulties working a mine are very great. Perhaps o of the greatest difficulties that the mines ha to contend with at the present time is t native labour question. Both as regar quantity and quality the native labour obtai able is very poor, most of the natives havi had no previous experience of mining. every district that I visited the general con plaint was that sufficient labour could not obtained. Although this is a difficulty whi time will no doubt put right, it is one which seriously hampering the mines to-day, and appears to me an evil which will not be quick overcome. It is not because the wages pa are not sufficiently attractive, for good "boys command as much as £2 a month and the food, the real reason appeared to me to b that the natives have a natural dislike to a work and especially to work with which the are quite unfamiliar. The natives have fe wants and consequently there is no necessit for them to work much. The progress of civi lisation will no doubt increase their wants especially in the matter of clothes.

The steps taken to get the natives to wor are not in my opinion satisfactory. The Britis South Africa Company have appointed official called "native commissioners" in variou centres, who have the power of enforcin labour, on what grounds I have not been abl to discover. The commissioners' police go t the kraals and collect gangs of natives and hand them over to any white man on paymen of two shillings per head, the employer having to pay the "boy" ten shillings a month and food. I have been informed that in some districts the discipline of the native police has been very bad, and that violence and brutality have been practised on the natives. It is not to be wondered at, therefore, that a native put to work at the bottom of a wet shaft, most ely never having been in or seen a mine fore in his life, will take the first opportunity run away, and will prevent others from coming work voluntarily. There are no doubt many anagers, who are careful to put the new nds at surface work first; but I strongly spect that the majority of employers do not ercise this sensible and humane treatment. is well known that the natives inform one other who is a good employer and who is t, and a mine, having once obtained a bad me, will find it hard to get any native to ork, except perhaps the raw recruit from e native commissioner, and he will take the st opportunity to escape. As I have already id, with time and proper organisation, suffi- ent native labour to meet the demand will be tained, but, at the present time, it is a difficulty the importance of which cannot be too much exaggerated.

As regards white labour for overseer work, I do not think much difficulty is, or will be, met with in obtaining what is required. The climate of Matabeleland, on the high central plateau, is fortunately healthy, and the difficulties of maintaining an efficient staff of white men, which has seriously hampered the mining industry in some parts of Mashonaland, are not likely to occur here. Fever, of course, is met with, but, as a rule, the serious cases are due to drink. I may mention that I have visited the excellent Government hospital at Buluwayo, and was informed that the fever cases treated there were almost entirely from the outlying mining camps, and that they were mostly due to intemperance and exposure.

As regards water, I do not anticipate any diffi- ulty will be met with in obtaining a sufficient upply for boiler and battery purposes. I have ot seen any places where water can be directly btained for motive power, though in the elukwe and Belingwa district it may be ossible to transmit water power by electricity.

The want of large mining timber for mining urposes is another difficulty that the miner ill have to deal with. In the districts I isited, the trees were all small and stunted, nd hardly suitable for mining purposes. The rees round the mines will soon be cleared off or fuel, which will only be obtained every ear at an increased cost. The coalfields of hodesia are too far from the mines to be of ny use until railroads are built.

The transport of all supplies and of machinery at the present time is both costly and slow. The roads are little more than natural tracks across country, and waggons take months to reach the mines.

Taking into consideration the adverse conditions under which the development of the mineral resources now rest, a rapid progress must not be expected. It must be remembered that gold mining in Mashonaland, which has now had a fair trial, having been opened in 1890, has, up to the present time been a failure. As far as I know, only one mine—the Cotopaxi, in the Victoria district*—has made any considerable output of gold.

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* Goldmann's "South African Mining and Finance" gives the total output from a ten stamp battery up to July, 1895, when the mill was shut down, at 2,328 ounces from 3,750 tons, or an average yield of 12·4 dwts. per ton.

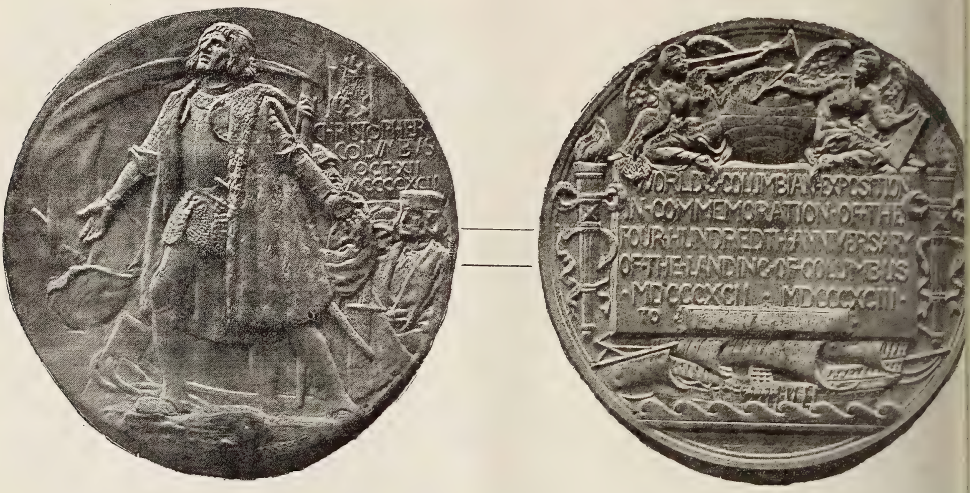
A large number of claims have been pegged out in Rhodesia, and are mostly held by numerous development companies, many of which appear to have paid more regard to the quantity than the quality of these claims. In travelling about the country, one is confronted on every side by pegs or notice boards, giving the name of the reef and the owner; but when one comes to look for the reef or the workings, the result is generally one of disappointment. There are, however, as already mentioned, many places where development work is being vigorously carried on with promising results; and I see no reason why there should not be, before long, a fair number of successful mines.

Whatever be the fortunes of Rhodesia, one thing is certain, that the men who are now making it their home, belonging to a race renowned for Colonial enterprise, and no be beaten by temporary difficulties, may v confidence be trusted to give it a fair trial.

CHICAGO EXHIBITION MEDAL.

The illustration represents the obverse and rev of the Chicago medal. The obverse shows Colum landing on the unknown island (probably one of Bahamas) which he discovered. The reverse is oc pied by a tablet, with the name and date of Exhibition and a place for the recipient's name.

The issue of the medals and diplomas has r commenced, and those for the industrial exh tors will all be sent out within a very few d Those for the Art Section and Women's Sect (the latter are very numerous) will follow with delay.



EDUCATION IN SWITZERLAND.

In Switzerland, education, according to Her Majesty's Secretary of Legation at Berne, is much less expensive than in England. In 1893 there were 8,390 primary schools in Switzerland, with 469,800 children, and an average of 50 pupils per teacher, of whom there were 6,290 masters and 3,180 mistresses. The expenses of the cantons were, on an average, 50 francs (£2) per pupil, or 8 francs (6s. 8d.) per inhabitant. There were 679 infant schools, with 29,432 children, and 485 secondary schools, with 31,800 pupils. Distribution, gratis, of food and clothing to poorer children in elementary schools is made in cases where the children have long journeys to make, or when in winter the weather is bad, and the children have to remain during the middle of the day in the school. In the Polytechnic School of Zurich, to which the Federal Government makes an annual grant of £36,800, there are 720 pupils, of whom 309 are foreigners. Instruction is given architecture, civil engineering, mechanics, chemist forestry, and training of teachers. The fees a about £8 10s. per pupil. There are commerc schools in six cantons, where the average expense the pupil is £18 10s. per head. There are sev universities, with a total of 3,742 male and 491 fema students in theology, law, medicine, &c., amo whom are many foreigners. There are, moreove technical schools of all sorts for instruction in far ing, dairy, vine culture, &c., established througho the country. At the agriculture and dairy schoo at Rutti (Berne), the pupils pay £16 a year, th balance of £30 being made up by subvention There are 18 *écoles ménagères*, of which one of th principal is at Worb, founded in 1886 by the *Socié Economique Bernoise*. There are three courses year, and the charge for the two winter, or shor courses is £5 5s. each, and for the summer course months, £10. Another, but more expensive, iool of the same sort exists at Hilterfingen, on Lake of Thun. There the charge is from two four francs a day, according to the room engaged, d this charge includes board, lodging, instruction, . At Rubigen there is a school for servants, at a st of £4 12s., for board, lodging, and instruction the course of five months. All these schools are narkable for the thoroughness of the instruction ven, and the very moderate rate of fees charged the pils. In the matter of education, the Swiss anifest great zeal, and have shown a great spirit religious toleration in all that concerns their ucational system. In some cantons where the pulation is a mixed one of Protestants and atholics, religious instruction is given on a fixed y and at stated hours, so that if parents wish eir children to have nothing but a secular education, they may absent themselves during that time. ixed schools also exist in some cantons when the opulation is composed of both Protestants and atholics, and are attended by children of either mmunion. These schools cannot be called secular, r in a canton like Zurich, for instance, where Prostants are in the majority, a Roman Catholic child ceives instruction in the elements of Christianity, ith readings from the Bible, with his Protestant hoolfellows, until he is 10 or 11 years old, when his pecial preparation for confirmation commences by he minister of his faith. This system also obtains St. Gall, where the Roman Catholics almost ouble the Protestants in number. The details of chool administration, organisation, and instruction re in the hands of the educational department of ach canton, and primary education is everywhere ompulsory. Excepting in the canton of Solothurn Soleure) this instruction does not necessarily take lace in the public schools, for parents are at liberty o have them taught at home or in private establishments; but the parent whose child is not taught t all is subject to very heavy penalties. At Zurich he minimum salary of a teacher in a primary school s £48, and in a secondary school £72, with very light increments after a certain number of years' service; and, after 30 years' service, a pension of one-alf of the salary. As regards holidays, there are bout 10 to 11 weeks in the year. School hours begin at 8 to 8.30 a.m. in winter and 7 a.m. in summer, and in the country school ends early, so as to allow the children to go to work in the fields. The number of school hours is five to six a day, and three days a week. Girls are given two consecutive hours' teaching, and practice in sewing, knitting, &c. It is made a point that the hours should be consecutive, and not an hour every day, which length of lesson is not considered sufficient for the purpose. There are in the confederation 5,386 school buildings of all sorts, including private schools. In 1893, in the 25 cantons of the confederation, the expenses on account of education were, by the State, £660,200, and by the communes £839,960, making a total of £1,500,160, or an average of about 10s. per inhabitant. Under the heading of technical instruction, £1,575,000 was spent in 1894.

A YEAR'S WORKING AND EXTENSION OF VICINAL RAILWAYS IN BELGIUM.

The kingdom of Belgium, divided into nine provinces, has an area of 2,945,591 hectares (11,373 square miles), inhabited by a population of 6,341,958, according to returns up to the end of last year. The total length of standard-gauge railways, which are chiefly worked by the State, is 4,556 kilm. (2,831 miles); and that of the vicinal or secondary lines 1,630·7 kilm. (nearly 1,014 miles), showing the latter to be 35·7 per cent. of the former. Compared with France, in which country economic railways have also made considerable way, Belgium has a far larger proportion of light lines, the latest statistics for the former country showing 36,595 kilm. (22,738 miles) of standard-gauge, and 3,871 kilm (2,405 miles of economic railways, the length of the latter being about 16 per cent. of the former.

The *Journal* of June 21, 1895 (vol. xliii., p. 726), contained an article entitled "The Working of Belgian Vicinal Railways," describing the object and operations of the Société Nationale des Chemins de Fer Vicinaux, which was formed about ten years ago, under the auspices of the Belgian Government, to raise funds, contributed by the State, the provinces, the communes, and individuals interested (each in proportion varying within fixed limits), for making and stocking light lines, not merely in districts where their traffic was almost a foregone conclusion, but also in those, shut out from means of communication, that would require development before a return on outlay could be expected.

The article above referred to brought the results achieved, as regards the construction and extension of lines and the financial condition, to the end of 1894; and the object of the following observations will be to record the progress that was achieved, both materially and financially, during last year. When that year opened there were 60 vicinal lines in operation, of which 40 showed better financial results than during the previous year's working, 36 yielded a dividend higher than that of 1894, and the working of only four others showed a balance on the wrong side. At that date the society possessed the concessions of 66 lines, 1,341½ kilm. (833½ miles) long, of which 62, measuring nearly 1,250 kilm. (776¾ miles) were actually in operation.

Compared with the above figures, at the beginning of the present year there were 63 lines in operation, of which 35 showed better financial results than during the previous year's working, 31 yielded a higher dividend than that of 1894; and of the four others one earned sufficient to completely pay off former loss, while the balance shown by a second will go towards paying past debts. Of the two remaining lines, which still show a balance on the wrong side (though the balance is smaller than before) that between Bourcy and Houffalize, in the Ardennes, made a loss of 1,229 francs (£49) as compared with 2,386 francs (£95) in 1894, and that between Arlon, the chief town of Belgian Luxemburg, and Ethe, one of 1,325 francs (£53) last year, against 4,016 francs (£160) in 1894.

It may here be mentioned that, although the society's lines have earned collectively, up to the end of last year, the large sum of 5,903,465 francs (£236,138), the total loss on working since operations were started only amounts to 81,000 francs (£3,240); and the general reserve fund formed to cover such loss has attained the sum of 409,661 francs (£16,386), the individual reserve funds of each line together amounting to more than half that sum. At the present time, among the lines which have been in operation at least a year, 23 pay a dividend of more than 3½ per cent., 4 others one of more than 3 per cent., and 11 others one exceeding 2½ per cent. Last year the nominal capital of the society was increased, by the issue of 35,000,000 francs 3 per cent. debenture bonds, to 98,000,000 francs (£3,920,000).

In the course of 1895, the Société Nationale obtained 15 concessions of new lines or extensions, including the Haecht-Aerschot-Tirlemont line of 45½ kilm., one of 30 kilm. between Ypres and Neuve-Eglise, one of 22 kilm. between Wavre and Braine-l'Alleud, near the field of Waterloo; one of 12 kilm. between Onoz and Fleurus, one of 18 kilm. between Tongres and Fexhe-le-Haut-Clocher, another between Tongres and Lanaeken, and a line of 14 kilm. between Boussu in Hainaut to the French frontier towards Bavay. With other lines and extensions, the total length at the beginning of the present year attained 1,558½ kilm. (968 miles), made up of 81 lines and extensions, reduced by fusion and modifications to 75 lines of 1,554½ kilm. During the present year four other concessions have been obtained, including that of a line 17 kilm. long between Louvain and Tervueren, bringing up the total length to 1,573 kilm. (977 miles).

There are at present, in operation, 65 lines, measuring 1,325 kilm. (823 miles); and 10 others are under construction. Of the former, 63 are worked by steam locomotives, one by horses, and one (that between Brussels and the Petite Espinette, 12 metres long and of metre gauge) by electricity on the trolly system, which has given such satisfactory results that the adoption of the same system is under consideration for the lines of the centre district, and those in the environs of Charleroi. Besides the lines actually conceded, 82 others of 1,380 kilm. (857½ miles) are under consideration by the Government.

During last year, five new junctions were effected between vicinal and standard-gauge lines, bringing up the number to 70, including 48 with the Belgian State system. Moreover, 17 new private sidings were made during the same period, bringing up the number to 123 of 59 kilm. (36 miles) collective length. Of the above number, 83 afford comm cation with industrial establishments, such as w and quarries, while 39 are purely agricultural.

Up to the end of last year the total amount s in making the lines and providing them with f plant and rolling stock was 52,544,455 fr (£2,101,778). The total receipts from last ye working amounted to 5,903,465 francs (£236,1 and the expenses to 4,091,110 francs (£163,6 giving a co-efficient of 69·3 against 70·57 in 18 It is noticed that among the lines which carry b goods and passengers, in 24 there was an incre and on 4 a decrease in both classes of tra while on 15 there was an increase of passengers, w falling off in goods, and in 4 just the reverse.

While the number of kilometres run last y was 6,149,263, against 5,802,132 in 1894, be an increase of 6 per cent., the number of perso accidents was less in 1895 than in 1894; and, usual, the most frequent causes were suicide, drunk ness, deafness, and imprudence. There was no l of life to passengers travelling by the lines; but th were injured, two while getting into or leaving train in motion, and one while passing from carriage to another. Nor were there any fatal a dents to the *employés*, but one was injured w shunting a train. All the 31 fatal accidents occur to persons unconnected with and not travelling by lines, 21 through drunkenness and deafness, a 4 through crossing the line in front of a train.

NAPLES SOAP.

The main ingredient of Naples soap, and tl which makes it a specialty, is that, instead of havi glycerine or fat for its basis, its main ingredient olive oil. Olive oil is made by subjecting the berr of the tree to a very high pressure and squeezing t oil out of them, but when this has been done to t utmost, there remains a large mass, composed pulp and the stones of the fruit, which still contai a considerable per-centage of oleaginous matt This mass of pulp and stone is valueless in itse and until a means had been discovered to extract t residuum of oil from it, it was to all intents a purposes a waste product. The stones, it is tru were ground to a fine powder and used in t adulteration of pepper, but otherwise the mass w commercially of small value. Consul Neville Rol says that, owing to the extent to which the olive tr is cultivated in Southern Italy, and the large quanti of oil manufactured and exported, there are fe districts more favourable for collecting the refu from the presses which forms the basis of Napl soap. Many experiments have been made from tim to time by Richardson Irvine and others, who em ployed volatile hydro-carbons for the purpose extracting the remaining oil from the refuse. The process however failed, in some cases from the dis agreeable smell of their products, and in others fro the want of efficacy of their inventions. The bes most perfect means known was invented by ss, a chemist of French or Swiss origin, who, by ns of a strong ley of diluents, of which sulphate carbon is a prominent ingredient, extracts a nish coloured oil from the refuse at a small cost, of sufficieut purity to form the basis of the best s. Of the Naples soaps exported to England, a e trade is carried on in that description which is wn as "Abeille 62." It has the appearance of a n and white marble, and contains 62 per cent. of e oil, every batch being chemically tested before ortation. It is used for wool washing, the nsing and preparation of silks and stuffs, and in connection with iron work, steel, and wire wing.

Notes on Books.

n-Russian Exhibition of 1896 in Nijni-Novgorod. Guide-book to the Town, the Fair, nd the Exhibition. St. Petersburg (Edward loppe).

This handbook, prepared by order of the Imperial mmission, has been compiled by State Councillor J. Miller. It contains an account of Nijni-vgorod, an historical description of the famous held there, and a guide to the sections of the teenth Pan-Russian Industrial and Art Exhibition. e last Pan-Russian exhibition was held at Moscow 1882, but the present exhibition occupies more n three times the space occupied by the Moscow . The central pavilion is a circular building with orchestra situated in the centre, other buildings placed in a park around this pavilion. This le volume is well illustrated, and contains a map European Russia as well as plans of Nijni-vgorod, the Fair, and the Exhibition.

talogue of Engraved National Portraits in the National Art Library: with a prefatory note by Julian Marshall. London, H.M. Stationery-office.

The collection of British, Irish, and some American rtraits described in this catalogue was commenced 1853, and among those who added to it by donan or legacy were Mr. J. Sheepshanks in 1857, the ev. Chauncy H. Townshend in 1868, Dr. Diamond, r. William Smith, Mr. George Smith, and others. 1867, a committee was appointed as advisers, and increase of the collection was carried on systemcally. The portraits were formerly arranged in rtfolios, according to classes, but this arrangement ing found inconvenient for reference, a simple angement in alphabetical order has now been opted. The catalogue is in an alphabet of the mes of the subjects of the portraits. Some bioaphical particulars are given, and each engraving described with the names of the painters and gravers. This valuable catalogue will form a useful companion to the catalogue of the paintings in the National Portrait Gallery.

Notes on the Geological Formation of South Africa and its Mineral Resources. By F. P. T. Struben. London: Stanford.

Geological Sketch of Africa South of the Zambesi, Accompanied by Coloured Sections. By F. P. T. Struben. London: Stanford.

This is a large coloured map on four sheets, with a descriptive account to accompany it. Mr. Struben states that his main object is "to prove that the gold-bearing conglomerates found in the Johannesburg district, including the Main Reef and Black Reef series, are not confined to Witwatersrand, but may be met with throughout the greater portion of South Africa," and that the southern portion of the continent is worthy of research for minerals. The author's investigations and studies regarding the general geological formation of the country date as far back as 1867.

The Great Eastern Railway Company's Guide to the Continent. Edited by Percy Lindley. London.

This is a cheap illustrated guide to Holland, Germany, Belgium, and Switzerland, giving a short account of the salient features of these countries, and showing how the tourist may see them to the best advantage. There is a short chapter on cycling on the Continent.

Historical Facts Relating to Music. By H. J. Taylor. London: Weekes and Co. 80.

The author has put together some of the chief facts in musical history in the form of questions and answers, which may be of use to students preparing for musical examinations. Part I. deals with composers and their works; Part II. with musical instruments; and Part III. with form. There are three indexes—1, of composers, inventors, &c.; 2, of musical works; 3, of instruments, &c.

National Art Library, South Kensington, Classed Catalogue of Printed Books. Ceramics. London. 80.

This is the first of a new series of subject catalogues undertaken by Mr. W. H. James Weale, keeper of the Art Library, with the object of enabling readers to ascertain what works that library contains on any particular branch of art. In addition to books and pamphlets specially relating to the subject, these catalogues will contain the titles of others which incidentally illustrate it. It is stated that the volume under notice contains nearly twice as many titles as any list of works on Ceramics yet published. It is, therefore, likely to be found of great value to students.

THE PRAISE OF THE NEEDLE. London: Liberty and Co.

An illustrated pamphlet showing what the needle has done for art, in the way of embroidery and other processes, from the days of Penelope downwards.

A DICTIONARY OF ENGLISH AND FRENCH MILITARY TERMS. By Albert Barrère. London: Hachette and Co. 1896.

The first part of this dictionary (English-French) was published last year, the second (French-English) has just been issued. So far as can be judged by inspection, the work seems very complete. To ensure the accuracy of the English vocabulary, the author secured the aid of several English officers. There are several appendices, giving the *chefs-lieux* of French army corps, the nomenclature of ordnance, the pay of officers and non-commissioned officers, and other information about the French army.

General Notes.

BRISTOL PHOTOGRAPHIC EXHIBITION. — The Bristol and West of England Amateur Photographic Association will hold their Triennial International Exhibition of Photographs, Apparatus, Appliances and Processes in the Galleries of the Academy of Arts, Clifton, Bristol, from the 14th December, 1896, to the 23rd January, 1897. Apart from photographs for competition, the Council of the Association ask if those who have any interesting examples of the history and progress of photography will kindly lend them for exhibition. All exhibits must be sent to the Honorary Secretary, not later than December 1st next.

TENNESSEE CENTENNIAL EXHIBITION, 1897.—This Exhibition, to be held from May 1st to November 1st, 1897, was referred to in the number of the *Journal* for May 22nd (see *ante*, p. 598). According to a recent American report, Centennial-park, comprising some 200 acres, two miles west of the State capital, is the site upon which the buildings of the Exhibition will be erected. The Administration Building has been finished, and the buildings for the agricultural and other exhibits are being pushed on. The arrangement of all exhibits has been placed in the hands of departments, each headed by a chief and a committee of gentlemen who are experts in their respective lines. The Exhibition will comprise the following sections: — Fine Arts; Architecture and History; Commerce and Liberal Arts; Agriculture and Horticulture and Farm Implements; Transportation; Electricity; Machinery; Geology, Minerals and Mining; Forestry and Forest Products; Live Stock; Pet Animals and Poultry; Military; Education; Hygiene; Medicine and Sanitary Appliances; Public Comfort. It is understood that no charge will be made for a reasonable amount of space for exhibits in any of the buildings, but each exhibit offered will be submitted, for acceptance or rejecti
to the Committee of Classification. Exhibit
concession application forms will be furnished
application, by the Director-General, Mr. E. C. Lev
Nashville, Tenessee.

INFLUENCE OF ACETYLENE ON COAL CONSU
TION.—When it is considered that our coalfields
not inexhaustible, observes Dr. Frank, of Charlott
burg, the influence likely to be exerted on coal c
sumption by acetylene gas constitutes a subject
considerable interest. If it be admitted that ten t
of gas coal generate 2,800 cubic metres (38,886 cu
feet) of lighting gas, only one-third that quantit
coal would be required to produce a ton of carb
or 3,000 cubic metres (105,949 cubic feet) of ace
lene gas, having a considerably higher illuminat
power than an equal quantity of ordinary light
gas. The above figures are based upon the estim
of 2,400 horse-power per hour being required
produce a ton of carbite, which is now sold at
francs (£16) per ton; but there is every reason
suppose that this price, as well as the amount
motive power, and consequently of coal, required
the production of this substance will soon be c
siderably reduced. Opinions vary greatly, howev
as to the yield of carbite in acetylene gas, from 225
350 cubic metres (mean 10,135 cubic feet) per t
being given by different authorities. Dr. Frank c
cludes that, although nothing definite can be p
dicted at present as to the final result of the strug
for supremacy by lighting gas, electricity, and ace
lene, the chances are not at all unfavourable to t
last-named substance.

INSURANCE COMPANIES IN GERMANY.—Owi
to the rapidly increasing business of the Germ
insurance companies—both life and fire—it has be
considered necessary to subject them to m
thorough Government supervision as regards th
working and management. To this end some ye
ago, the Prussian Government issued detailed i
structions to all insurance companies operating
Prussia, regarding the making up of their accoun
To render the Government control more effective,
resolution was passed by the Reichstag with espec
regard to the improvement in calculating and t
working up of insurance matter in the provinc
where frequently clerks entrusted with such wor
lacked the necessary technical knowledge involved
insurance business. The Prussian Budget for 1896-
provides for the employment of one "Insuran
Technical Expert," to be attached to the Minist
of the Interior, at a salary of £360 per annum, a
for four "Insurance Revisors" for the provinces,
salaries varying between 4,500 and 5,700 mar
(£225 and £285) each. The duties of these ne
officials will be the continual working up of
insurance matter, with especial reference to death
annuities, assets, &c. The United States Commerci
Agent at Weimar says that, in view of the impor
ance of the subject, the change evokes gener
interest and approval.

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CHAIRMANSHIP OF COUNCIL.

On Monday, 6th inst., at their first meeting fter the annual election, the Council elected Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., as Chairman of Council for the ensuing ear. The various Committees were also reppointed.

EXAMINATIONS, 1897.

The dates fixed for the Society's Examinations in 1897 are Monday, March 22nd, Tuesday, 3rd, Wednesday, 24th, and Thursday, 25th.

The Programme of Examinations is in course of preparation, and will be issued shortly.

The results of the Examination in 1896 are now ready, and have been issued to the various centres of examination. Copies of the list have also been sent for distribution to the successful candidates.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 1st July, too late for the results to be included in the Report of the Council.

Some modifications have been introduced in the system of examination for the present year. Candidates are asked to select for themselves which of four standards they choose to be examined in. Standard I. is easy, Standard II. moderately difficult, Standard III. difficult, and Standard IV. very difficult. For each standard a list of music is given, and a selection from this list is sent to the candidates six weeks previous to the examination. Candidates are expected to play or sing pieces from the selected list, as well as to play a piece, or a portion of a piece, at sight.

In all 365 candidates entered, 11 of these took up two subjects, so that there were 376 examinations. Of these there were 330 passes and 46 failures. The following were the subjects taken up:—Piano, singing, violin, viola, mandolin, and organ. 258 entered for the piano, of whom 217 passed and 8 obtained medals; 58 entered for the violin, of whom 54 passed and 7 obtained medals; 1 took a medal for the viola; 1 passed with the mandolin; 9 entered and all passed for the organ, 1 taking a medal; 49 entered for singing and all but 1 passed, 2 obtaining medals.

Mr. John Farmer, of Balliol College, Oxford, and Director of the Harrow Music School, acted as Examiner, Mr. Ernest Walker, M.A., Mus.Bac. Oxon., and Mr. Burnham Horner, as Assistant-Examiners.

Proceedings of the Society.

CANTOR LECTURES.

ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. Fleming, F.R.S.

Lecture I.—Delivered January 20, 1896.

The Action of the Transformer.

In the last ten years the alternate current transformer has been developed from an experimental instrument into a practical appliance of immense utility. According to recent statistics, there are at present about fifty alternating current electric supply stations in the United Kingdom, supplying not less than 1,100,000 8 candle-power lamps. This amount of lighting requires the expenditure of 54,000 horse-power, or 40,800 kilowatts at full load, and hence there must be transformer capacity in the United Kingdom at the very least equal to 40,000 kilowatts. These transformers, as presently to be explained, all contain an iron core, which has to be magnetised and demagnetised 200 times a second, or 6,000,000 times a year. The total weight of iron cores in the whole of these transformers will be certainly not less than 400 tons, and it will require at least 400 kilowatts to maintain the magnetisation of these cores. If these transformers are connected with the circuits only, on the average, 4,000 hours a year, it is very easy to see that the magnetisation of the cores of the transformer will require not less than 1,600,000 Board of Trade units spent per annum in magnetism, and this means at least 16,000,000 lbs. of coal, or 8,000 tons. Hence, in the United Kingdom, we have buried away somewhere or other at least 400 tons of iron forming the cores of transformers, and these involve at least an expenditure of 8,000 tons of coal, costing some £6,000 sterling to maintain that magnetisation. It is, therefore, easily seen that the study of the construction of the alternate-current transformer, and its possible improvement, is one which is not at all unimportant, from an engineering point of view.

I propose to assume in these lectures that the majority of those present are acquainted with the principal facts connected with the flow of alternating currents of electricity in inductive circuits, and to address myself more particularly to the study of alternating current transformers from a practical point of view, discussing in the four lectures of this course the action of the transformer, the construction of the transformer, the testing of the transformer, and the employment of the transformer. You are all probably aware that an alternating current transformer in its simplest form consists of two circuits of insulated wire which are wound upon an iron core, and that this device operates to transform electric energy in such fashion that the flow of an alternating current through one circuit is made to produce another current in the second circuit, with an increase or decrease of current strength taking place at the expense of potentials. The transformer does no more than any lever, wheel and axle, or simple machine in transforming power from one form into another form. The general operation of the transformer or induction coil, in whatever form it may be taken, is then as follows:—Through one of the circuits, called the primary circuit, is passed an intermittent, interrupted, or alternating current. This primary circuit is interlinked with a magnetic circuit, and the primary circuit establishes in the magnetic circuit an intermittent, interrupted, or alternating induction; the magnetic circuit is interlinked with a secondary circuit, and the variation of magnetic induction in the core creates an electromotive force in the secondary circuit, which at any instant depends upon the rate of change of the total induction linked with the secondary circuit.

As the word "induction" will very frequently be mentioned during the succeeding lectures, it is exceedingly important there should be no ambiguity in your minds as to the meaning of this term. We may help ourselves by regarding the analogy of conduc
ing circuits and magnetic circuits. Consid
a conducting circuit in which an electr
current exists. As long as the circuit is clos
we recognise the presence of the curren
either by heat produced in the conductor,
by electrolysis, and by various magnetic a
dynamical actions in the medium round
We select some one of these effects, say t
electrolytic effect, and we base our quan
tative definition of current strength upon i
thus, for instance, the accepted definition
an ampere is that it is a current which in o
hour deposits, electrolytically, 4·025 gramm
of silver. The cause, whatever its nature, pr
ducing the current is called the electromoti
force. If we draw any line linked with
surrounding the conductor conveying the cu
rent, whether that line be included in a ma
netic material like iron, or a non-magnet
material like air, we find a physical actio
taking place in that path which is called ma
netic induction, and the immediate cause of th
magnetic induction we speak of as magnet
force. We measure this induction by one
the effects it can produce, namely by the electr
motive force which it can set up in anoth
conducting circuit linked with the magnet
circuit when that induction is suppressed
reversed at a given rate. Faraday showe
that the proper measure of the total magnet
induction linked with any conducting circu
was the total quantity of electricity set flowin
in the circuit when the magnetic induction
suppressed or reversed. In practical work it
better to abandon the rather academic phras
"number of lines of force" or induction, s
much used, and to think of the induction as
physical effect produced in the magnetic circui
its value being reckoned in *webers*, the induc
tion being produced in the magnetic circu
by magnetic force, just as electric curren
reckoned in amperes is produced in the con
ducting circuit by electromotive force. Henc
we have this definition of a unit of magneti
induction. A unit of magnetic inductio
called one weber, is an amount of inductio
which, when linked or unlinked with
circuit of one turn, and having a resistanc
of one ohm, causes one coulomb of electri
quantity to flow round the conducting circuit
Generally speaking, if induction is measure
in webers (1 weber $= 10^8$ C.G.S. units), w
have the following relation between th
magnetic induction, the number of turns o
linkages which the secondary circuit make
round the line of the induction, the resistanc

ohms of the secondary circuit, and the total antity set flowing in the secondary circuit koned in coulombs.

Webers × linkages = coulombs × ohms.

Since one weber is a larger amount of induc- n than is met in any single transformer core dynamo magnet, it is convenient to take the illionth part of this as the practical unit, z., the *microweber*, and to commit to emory the following rule:—Microwebers × kages = microcoulombs × ohms, and to collect that one microweber is equal to 100 G.S. units of induction, or what would com- only be called 100 lines of force. In order measure induction, we require then a llistic galvanometer as a practical instru- ent to measure electric quantity; and we n at once make a measurement of the in- ction in any magnetic circuit by determining e quantity of electricity set flowing in a rcuit of a known number of turns which is nked with this induction, and then unlinked, withdrawing the circuit or reversing the duction. As a practical illustration of these ethods, it will be useful to make a measure- ent of the induction existing in this closed on ring, when it is magnetised by a current owing round it. The ring, as you see, is ound over closely with one layer of wire, hich we will call the primary circuit. If we easure the mean perimeter of the ring, and unt the number of turns, it is a simple matter obtain the number of turns per centimetre. a current, measured in amperes, is set owing through this circuit, then it can easily e shown that the magnetising force acting pon the iron is equal to 1¼ times the turns of ire per centimetre, multiplied by the ampere urrent flowing through the circuit.* This agnetising force produces in the iron a cer- in magnetic induction which is measurable microwebers. In order to find out the magni- de of this induction, we put upon the ring a econdary circuit of a known number of turns. Ve then employ a ballistic galvanometer suit- ble for measuring electric quantity, and we ust first calibrate this ballistic galvanometer o determine the excursion or throw of the eedle, when a given quantity of electricity easured in microcoulombs is sent through it. his is most easily done by charging a con- lenser of half a microcoulomb by means of a tandard cell having an electromotive force f 1·5 volts, and discharging this quantity of 1·5 × ·5 = ¾ microcoulomb through the galvanometer. This produces a certain throw or excursion of the needle, and we may then assume that for any other throw of the needle the quantity of electricity producing it is proportional to the throw as determined by the above calibration. In order to measure the magnetic induction in the iron circuit, all that we have to do then is to connect the secondary circuit having a known number of turns, and the resistance of which, added to that of the galvanometer and connecting wires must be determined in ohms, and observe the throw of the galvanometer needle, which is produced when the primary current is reversed. Ascertaining from the previous calibration the electric quantity measured in microcoulombs represented by this throw, we multiply that number by the total resistance of the secondary circuit, including the galvanometer measured in ohms, and divide the product by the number of linkages or turns of the secondary circuit. This quotient gives us double the induction measured in microwebers existing in the iron core at the time when the steady current is flowing through the primary circuit, hence the induction is at once measured in microwebers.

Returning then to the alternate current transformer, we may classify transformers, converters, or induction coils as they are also called, according to their construction, and their use as follows:—Transformers may be (*a*) iron-core transformers, with a core wholly or partly of iron, (*b*) air-core transformers with a core or magnetic circuit wholly of non-magnetic substance. Iron core transformers may be (*c*) closed iron circuit transformers with a magnetic circuit wholly of iron, (*d*) open iron circuit transformers with a core partly of iron. Transformers may be used (*e*) to transform a potential difference in a constant ratio, in which case they are called constant ratio transformers, (*f*) to transform a current strength in a constant ratio, in which case they may be called constant transformers. The transformers may be employed (*g*) to raise pressure or current, and they are then called "step up" transformers, (*h*) to lower pressure or current, and then they are called "step down" transformers. This is not an exhaustive classification, but it is sufficient for practical purposes. By far the most important member of the group is the constant potential closed iron circuit transformer employed with alternating currents taken from a constant potential primary circuit. This may be considered from its importance to be the chief of the clan, and to it, therefore, we shall pay most attention. In order to possess a complete knowledge of the operations and action of such a transformer, we require to know the nature of the operations going on in all parts of it at the same instant. We have seen that the broad general action of the transformer as employed with alternating currents is as follows:—If an alternating primary current is passed through the primary circuit it acts upon the iron core with an alternating magnetic force, and creates in the iron core an alternating magnetic induction. If a secondary circuit is also wound round the same iron core, the periodic variation of magnetic induction in the magnetic circuit creates a periodic electromotive force in the secondary circuit, and if that circuit is closed, creates in it a peri secondary current. The method which of years has proved most fertile in adding to real knowledge of the subject of the transfor is that of delineating graphically the var periodic quantities concerned, by a pro which is called alternating current c tracing. It is, therefore, necessary to st this process in some detail. Suppose we have an alternating current dynamo alternator in operation, we know that potential difference between the termi of this machine undergoes periodic va tion, and that it passes from one maxim in one direction to another maximum an opposite direction. At any instant machine is producing an electromotive fo which is called its instantaneous value. S

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* *Vide*, "The Alternate Current Transformer," Fleming. ew Edition. Vol. i., p. 23. The *Electrician* Printing nd Publishing Co., 1, Salisbury-court, Fleet-street, E.C.

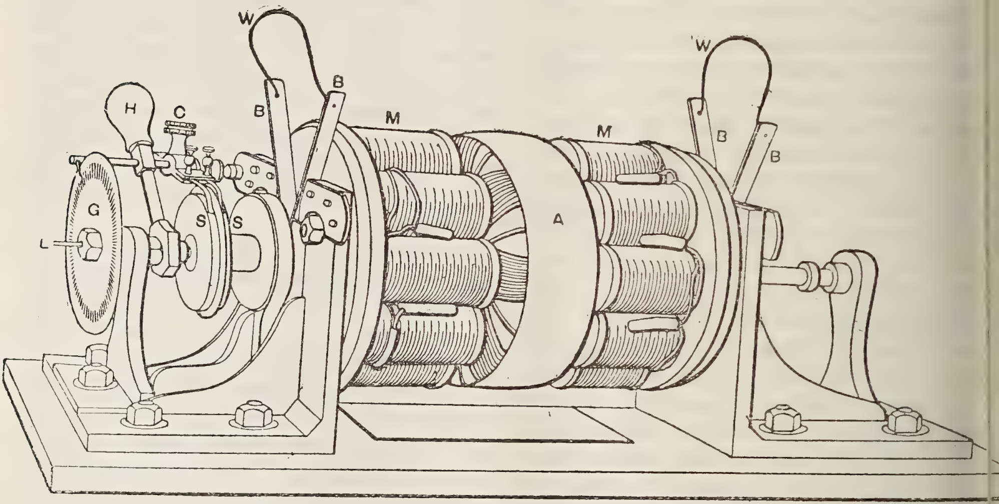

Fig. 1.—The Alternating Current Curve Tracer.

pose that the alternator terminals are connected to a condenser, the potential difference of these condenser plates follows the same law of variation as the electromotive force of the machine. If the condenser is removed at any instant, and the potential difference of its plates examined that will give us the potential difference of the terminals of the alternator, or the electromotive force of the alternator, at the instant when the condenser was disconnected. The practical arrangements made for doing this, which I have found it convenient to use, are as follows:—A small alternating current motor (see Fig. 1) has its field magnets excited by a constant continuous current, and its armature traversed by a current coming from the alternator under examination. The shaft of this alternating current motor carries an ebonite disc, on which is plac a small steel slip. As the disc rotat the steel slip passes at each revoluti underneath two small steel springs, ligh touching the ebonite disc. The steel sl therefore, electrically connects these sprin (which are otherwise insulated) together, a this connection takes place at each revoluti The two springs are carried on an insulat bar, which is capable of being moved rou an arc of a circle in such a manner that t instant when the springs are connected togeth can be altered and determined by the angul position of the rocking bar, carrying t two springs as read off on a scale. If th little alternating current motor is started step with the alternating current machine, will keep in step with it, and will close th cuit of the two springs once during every olution at an instant during the complete ase of the electromotive force depending on position of the springs. These two springs, nstituting the revolving contact breaker, connected in series with a small battery of thanode cells, B (see Fig. 2), and these again ith an electrostatic voltmeter, V, across the rminals of which a condenser, C d., is ined. This appliance may then be employed determine the form of the curve of an ternating current or an electromotive force follows:—Suppose it be desired to deter- ine the curve of electromotive force of any ternator, the contact breaker is joined across e terminals of the alternator, and the reading the voltmeter is taken as the rocking arm rrying the springs is moved round by steps rough an angular interval corresponding to ne complete period. At equal intervals during ie movement, the electrostatic voltmeter is ad, and in order to bring the readings within ie best part of the scale of the voltmeter, a lected number of the cells of the battery B re placed in series with the voltmeter so as add a known electromotive force to the electromotive force being measured.* By the employment of a revolving contact breaker of this form, a number of curves were taken from the alternating current machines in the City of London Electric Lighting Station at Bankside, some of which are shown in the accompanying figures.

iagram of Connections for obtaining E.M.F. and Current Curves of a Transformer.

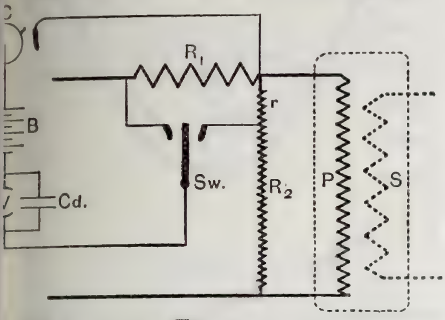

FIG. 2.

E.M.F. Curve of A.14 Mordey Alternator on Full Load (Water Resistance) 50 Amps.

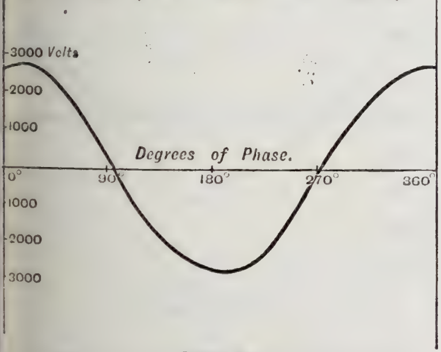

FIG. 3.

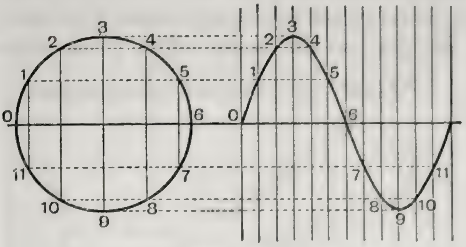

FIG. 4.

E.M.F. Curve of an A.20 Mordey Alternator at No Load

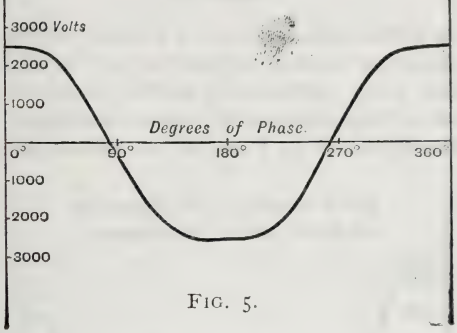

FIG. 5.

Fig. 3 represents the electromotive force curve of a Mordey alternator on full load, the load being a water resistance. It will be seen that the curve of electromotive force is no very far from a simple periodic or simple sine curve as shown in Fig. 4. Fig. 5 shows the electromotive force curve of a larger Mordey alternator at no load, and Fig. 6 shows the

E.M.F. Curve of A.14 Mordey Alternator at No Load.

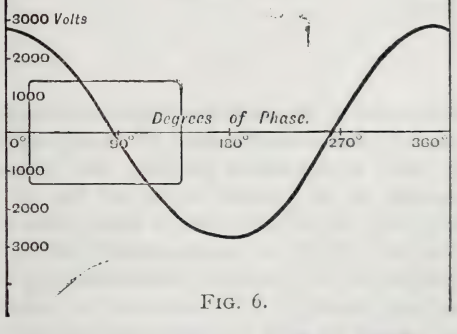

FIG. 6.

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* For further details see "The Alternate Current Transformer." Fleming, vol. i. (new edition) p. 521.

manner in which the electromotive force curve, at no load, is related to the position of the pole-piece represented by the rectangular line. The electromotive force curve of an alternator is, however, not by any means always so nearly simple periodic curve. Fig. 7 represents the electromotive curve of a Thomson-Houston alternator taken at no load, the position of the field poles with respect to the electromotive curve being shown by the square rectangles in the figure. Fig. 8 shows the electromotive force curve of the same machine when working on a highly-inductive load of transformers. In order to determine the form and relative position of the current curve, all that it is necessary to do is to put in series with the alternator circuit a non-inductive resistance sufficient to carry without sensible heating the outgoing current. By connecting the revolving contact breaker and associated voltmeter with the terminals of this non-inductive resistance we can delineate the curve of fall of potential down the non-inductive resistance which is identically the same thing as the curve of current in the resistance.

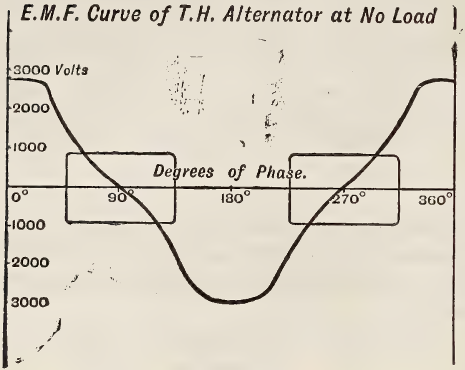

FIG. 7.

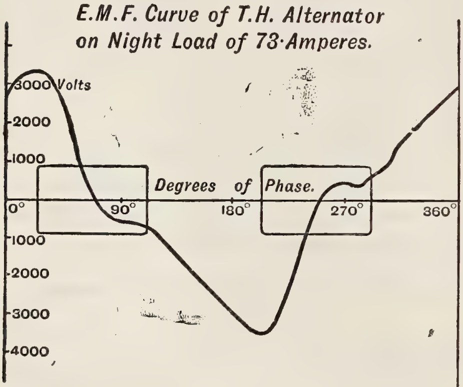

FIG. 8.

In this manner have been determined tl current curves taken from the above-mentione machines, both on inductive and non-inducti loads. Fig. 9 shows the electromotive for

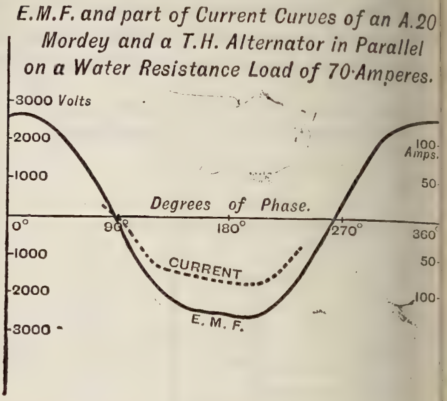

FIG. 9.

curve and part of the current curve of a Mord and Thomson-Houston alternator on a wat resistance; and Fig. 10 shows the curre curve and part of the electromotive force cur of a Thomson-Houston alternator, working a water resistance. These diagrams sho that when an alternator, having an electr motive force of 2,000 volts, is working on water resistance this load is an absolutely no inductive load, the current curve being pract cally perfectly in step with the electromoti force.

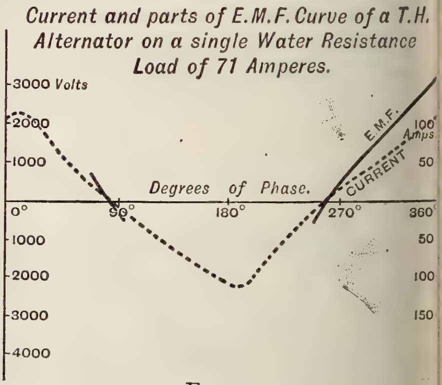

FIG. 10.

This leads to the conclusion that in testin a high tension alternator for efficiency, it quite sufficient to load up the machine c water resistance to measure the current goin out of the machine as ordinarily measured c an alternating current ammeter, to measu the difference of potentials at the terminals the machine, as measured on an alternatin rrent voltmeter, and to multiply the values the two readings together, and thus obtain e true power in watts being given out by the achine on the water load. There is no uestion of difference of phase in this case.

Current and part of E.M.F. Curves of an A.20 Mordey Alternator on Night Load of about 72·Amperes.

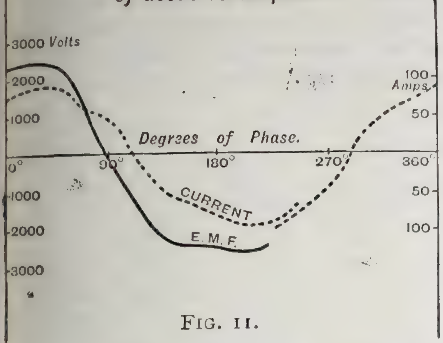

FIG. 11.

f, however, the alternator is working upon an nductive load, such as a number of transormers lightly loaded, then the current curve ags behind the electromotive force curve by a definite amount at the zero value.

E.M.F. and Current Curves of an A.20 Mordey Alternator on Night Load of 70· Amperes.

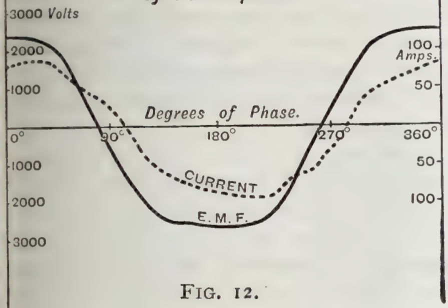

FIG. 12.

E.M.F. and Current Curve of a T.H. Alternator on Night Load of 72·Amperes.

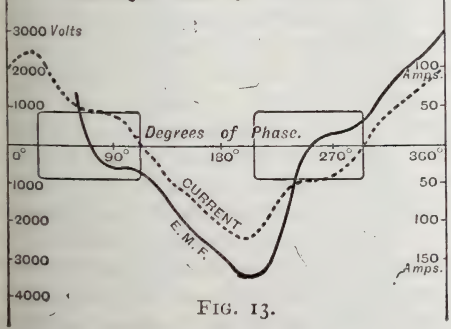

FIG. 13.

This is shown in curves, Figs. 11, 12, and 13, giving respectively the electromotive force and current curves of a Mordey alternator, and a Thomson-Houston alternator working on transformers lightly loaded. It will be seen that the difference of phase between the current and electromotive force curves is different at different parts of the curve; in the case of the Thomson-Houston alternator there is no difference of phase between the maximum values of the current and electromotive force, but a considerable difference between the zero values.

T.H. Transformer at No Load.
Primary Current Curve.
Primary E.M.F. Curve off T.H. Alternator at No Load.

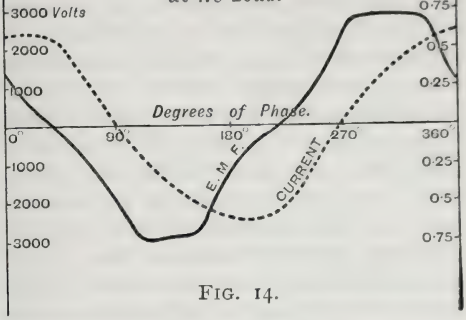

FIG. 14.

In the diagram of the Thomson-Houston alternator the position of the field poles is shown by the square rectangles, which, therefore, indicate the manner in which the electromotive force curve is related to the field poles in the machine.

E.M.F. and part of Current Curves of T.H. Alternator on single Water Resistance Load of 70 Amperes.

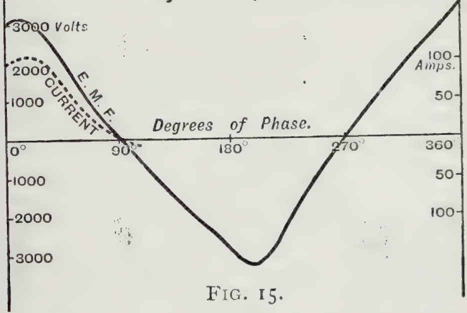

FIG. 15.

It must not be supposed that the form of the current curve, or of the electromotive force curve, is a fixed attribute of the alternator, that is to say, we cannot speak of the electromotive force curve of an alternator as if it were something unchangeable and peculiar to that machine. It often largely depends upon the nature of the load. Thus, for instance, in Fig. 14 is shown the form of the electromotive force curve of a Thomson-Houston alternator when very lightly loaded, and in Fig. 15 is shown the electromotive force curve of the same machine when loaded on a non-inductive resistance to a fair proportion of its full load; whilst on referring to Fig. 13 we see the form of the electromotive force curve of the same machine when working on an inductive load, and it will be noticed how very different in form are those three curves. Generally speaking, in a machine like the Mordey alternator with a very small armature reaction, there is very little change in the form of the electromotive force curve with the nature and amount of the load on the alternator, but in the case of a machine like the Thomson-Houston or Westinghouse alternator with a large armature reaction there is a very considerable change in the form of the electromotive force curve which changes in the amount and nature of the load. In the above cases the form of the electromotive force curves have been set out graphically in what are called wave diagrams, in which the horizontal ordinates represent time, and the vertical ordinates represent the magnitude of the quantity which is varying, whether electromotive force or current. For some purposes this method is not so convenient as that of setting out the curves in the form of polar diagrams.

The differences between these two methods—graphically delineated a periodic quantity—are shown in Figs. 16 and 17. In Fig. 16, part of the curve of the electromotive force of a Thomson-Houston alternator on an inductive load is shown. In Fig. 17 the same quantity is delineated in a polar curve. Instead of drawing vertical ordinates at equal distances to represent the instantaneous values of electromotive force, radii are drawn from a point, O, at equal angular intervals, the magnitudes of which are respectively proportional to the instantaneous values of the periodic quantity.

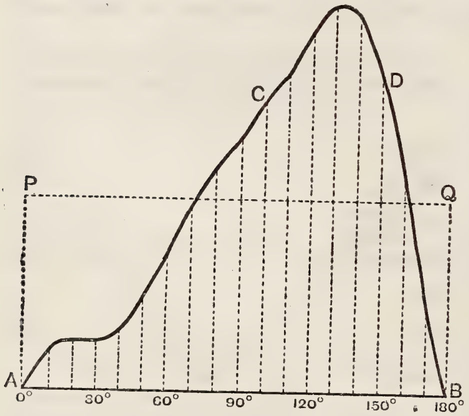

FIG. 16.

A curve, B C D is thus obtained, which called a polar curve. It has this interesti property, that if we find the area of the pol curve, and describe a semicircle on a line, P passing through the pole, O, the area of whi is equal to the area included by the pol curve, B C D, it can easily be shown that t radius of this semicircle represents the squa root of the mean of the squares of all the rac

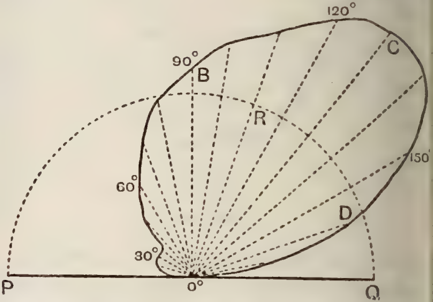

FIG. 17.

of the polar curve. This quantity is nc generally called the R.M.S. value, or the roc mean-square value of the periodic quantit By some writers it has been called the effecti or virtual value. Ordinary alternating curre ammeters and voltmeters give, as is well know the R.M.S. value of the periodic quantity th are measuring.

Returning to Fig. 16, if we construct rectangle, A P Q B, equal in area to the are included by the wave curve, A C D B, then it easily seen that the height of this rectangl namely, A P, represents the true mean value the periodic quantity represented by the ord nates of the wave curve. In the case of an periodic quantity, such as a periodic electro motive force or current graphically delineatec it is found convenient to have a term to denot the ratio between the true mean value of th curve ordinate and the root-mean-square valu and this is called the *form factor* of the curve. Having thus seen the manner in which we ca experimentally determine the form of a electromotive force or current curve, whic represents the different instantaneous value of a periodic electromotive force or curren we can now proceed to discuss the manner i which these methods have been applied i the study of the alternate current trans former. Let us first suppose that the trans former to be studied is a constant potentia transformer, having two windings, a primar

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[*] For further information on this point see "The Alternat Current Transformer," Fleming, vol. i. (new edition), p. 583 published by "The Electrician" Printing and Publishin Company, 7, Salisbury-court, Fleet-street, E.C.

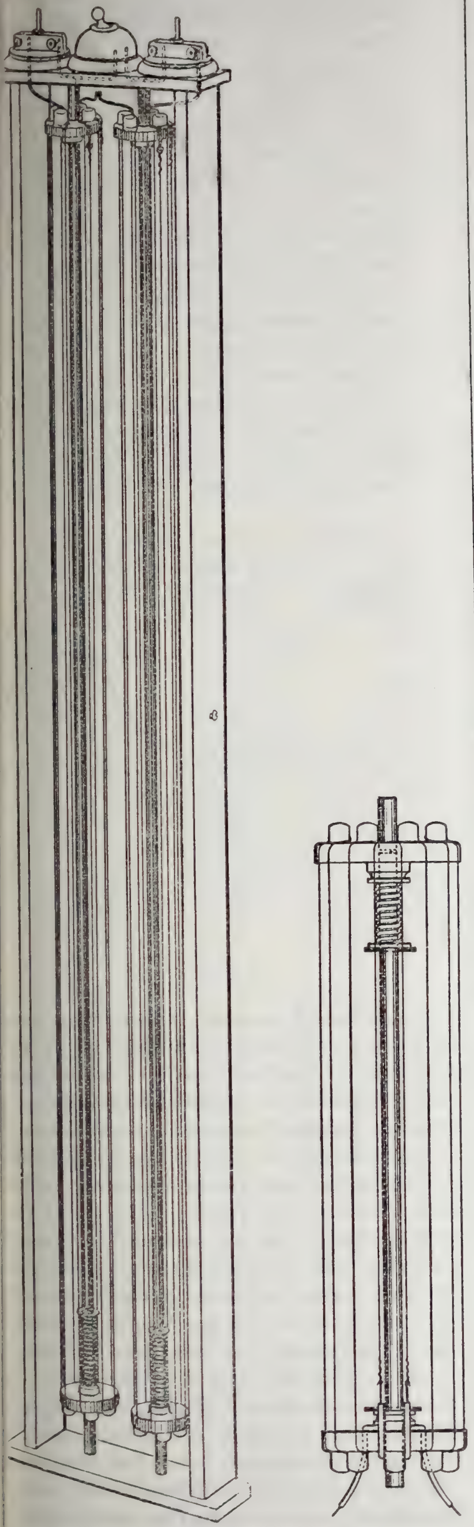

FIG. 18.—NON-INDUCTIVE RESISTANCES.

and a secondary coil, both wound round an iron core forming a completely closed iron magnetic circuit. Let the primary coil be joined up through a non-inductive resistance, R¹, as shown in Fig. 2, with a circuit of constant potentials, and let the contact-breaker above described, denoted by C, and the electrostatic voltmeter, V, be applied to determine the form of the current curve flowing into the primary coil, P, of the transformer. In order to delineate the form of the curve of primary potential difference, it is necessary to put across the primary terminals of the transformer a non-inductive resistance, R², which is divided in a definite ratio, so that by measuring a fraction, say $\frac{1}{20}$ of the whole difference of potentials between the terminals of the primary circuit of the transformer we can determine the total potential difference. After much experimenting I succeeded in devising a form of resistance which is now before you, and which is very convenient for this purpose. It is called a resistance cage. It consists, as you see, of a series of brass rods held in a wooden frame, each rod carrying a pair of porcelain heads, with porcelain pins on them (see Fig. 18), and these porcelain heads are kept pressed apart by a spring. Over the pins on these porcelain heads is wound, in zig-zag fashion, a platinoid wire, so as to form a perfectly ventilated non-inductive resistance. Each of these resistances is adapted for withstanding 100 volts pressure, and carrying one half or one ampere, and a series of 20 of these resistances can be put across the primary terminals of a transformer, and will withstand the pressure of 100 volts for as long as necessary. By measuring the full of potential and delineating the periodic value of the difference of potential between the terminals of one cage, which forms one of a series of twenty, we can delineate the whole difference of potential between the terminals of a transformer. In this way we can take curves of primary current and primary electromotive force on the high tension side of a transformer. In the next place we can perform the same operation on the secondary side of the transformer, and obtain the secondary terminal potential difference curve, and also, if the transformer is sending a secondary current, the secondary current curve for that transformer. When these experiments are carried out for any good closed circuit transformer, and delineated in the form of a series of curves set in their proper relative position, which it is convenient to call a transformer diagram, we find the following results:

—In the first place, the curve of secondary potential difference is always an exact copy to a reduced scale of the curve of primary potential difference, and it is very nearly exactly in opposition to it in phase. This is shown in Fig. 19 and Fig. 20. Fig. 19 gives us the curves of primary and secondary electromotive force of a Thomson-Houston transformer taken off a Mordey alternator. If the transformer is taken at no load, and if the curves of primary and secondary electromotive force are drawn to such scale as to their maximum ordinates equal to one another, and if they are drawn on the same side of the axis, then it is found that at no load the transformer curves exactly overlap one another. If the transformer is partly or wholly loaded up on its secondary side, so as to cause it to send a secondary current, then

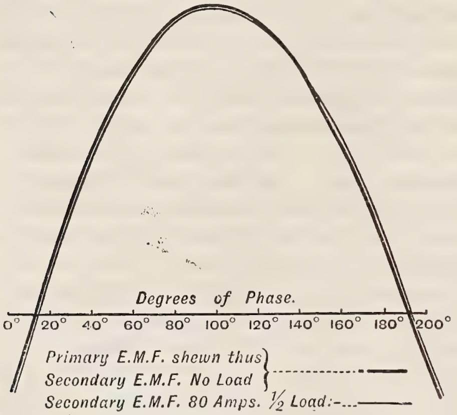
Curves of Pr. & Sec. E.M.F. of T.H. Transformer taken off an A.14 Mordey Alternator with no other Load.

FIG. 19.

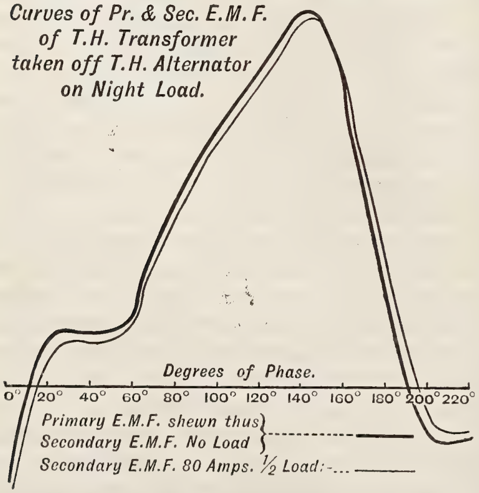
Curves of Pr. & Sec. E.M.F. of T.H. Transformer taken off T.H. Alternator on Night Load.

FIG. 20.

the secondary electromotive force is a lit advanced in phase over the curve of prima electromotive force as shown in Fig. 1 Fig. 20 shows the same thing for the sa transformer taken off a Thomson-Houst alternator. Hence we see that the clos circuit transformer acts like an electric pantograph: it copies electrical potenti difference, and the curve of secondary pote tial difference is always a nearly exact copy the curve of primary potential difference; b to a reduced scale depending on what is call the transformation ratio of the transforme On delineating the curve of primary curre of the transformer when the transformer taken at no load, as shown in Fig. 21, we s that the curve of primary current, when t secondary circuit is open, differs in pha from the curve of primary potential differenc

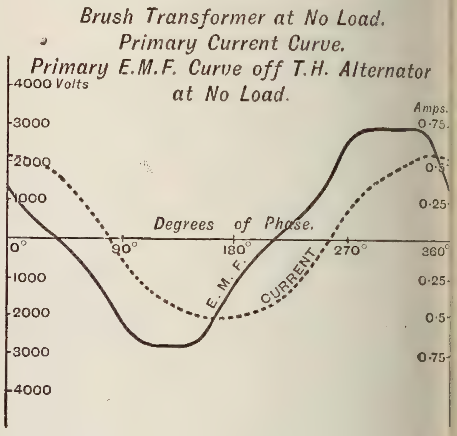
Brush Transformer at No Load. Primary Current Curve. Primary E.M.F. Curve off T.H. Alternator at No Load.

FIG. 21.

It lags behind it, and the same thing is show by reference to Fig. 14, where the curve c primary electromotive force for another transformer taken off the same alternator is given It will be seen that even if the same alternato is employed for the test, the curve of primar current at no load is not the same in forn in the case of all transformers. The forn of this primary current curve is governed b the nature of the iron employed in the core We then notice that even in cases where th primary electromotive force curve is more o less approximately a sine curve or simpl periodic curve, the curve of primary current i always more irregular. Having in this manne delineated the curves of primary current primary electromotive force and secondar current, we have then to determine the manne in which the induction in the core is varying with relation to these other varying quantities e can draw out a curve of induction from curve of a secondary electromotive force in following manner.

Since the secondary electromotive force of transformer at any instant is measured by rate at which the magnetic induction linked th the secondary circuit is varying, we can nstruct the induction curve in the following ıy, as shown in Fig. 22. The curve marked M.F. represents a transformer secondary ctromotive force curve. The whole area of curve is divided into two equal parts a vertical line. Starting from this verti- l line, half of the curve, say the right- nd half, is divided up into narrow strips equal area, which are represented by cross-hatched slips. The areas of these ry narrow slips are then taken with the nimeter, and we set off, starting from the

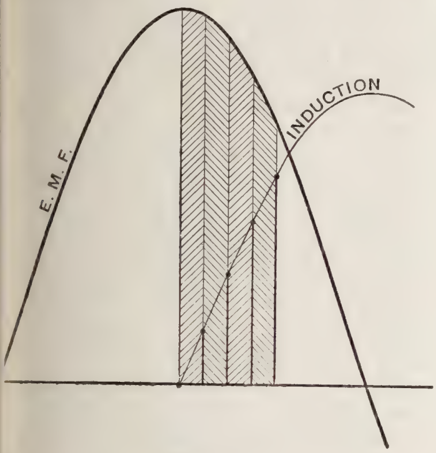

Fig. 22.

ddle point of the time axis, the curve of luction by the following method. Starting m the middle point of the time line we set- on the right-hand side of the first slip an linate which represents to some suitable le the area of slip No. 1. On the right- ıd bounding line of slip No. 2 we then set- an ordinate equal to the same scale of the al areas of slips No. 1 and 2 together. On right-hand bounding line of the third we then in the same way set-off an ordi- e representing the total area of the first ee slips, and so on. In that way we obtain nts on a curve which represents what is led the time integral of the electromotive e curve, and this is, therefore, the proper resentation for the induction curve. In er to determine the scale to which this uction curve is drawn we must know what he value of the maximum ordinate of the induction curve. This can be done in the following manner. If B represents the induction in the core, S the cross-section of the core, N_2 the number of turns of the secondary circuit, n the frequency of the alternating current, and f the form factor of the secondary circuit curve; then it can be shown that the root-mean-square value of the secondary electromotive force is equal to $4\,f.\,n.\,N_2\,S\,B$; and hence, since the root-mean-square value of the secondary electromotive force is immediately known from the delineated curve, and also its form factor, we can easily calculate the value of B, that is, of the induction.* That is to say, in this manner not only can we thus delineate the curves of current electromotive force, but also the induction, and represent them graphically on the same diagram. In Fig. 23 are shown the curves of primary electromotive force, primary current, and induction for a Ganz transformer taken at at no load. The curve of induction can be determined in the above described manner, not only from the curve of secondary electromotive force, but also from the curve of primary electromotive force. If this is done, it is found that two curves of induction so obtained do not exactly coincide. The reason for this is the magnetic leakage of the transformer. This last term is best defined by saying that when the transformer is at work, and sending a secondary current, the whole of the magnetic induction which is linked with the primary circuit is not linked with the secondary circuit. There is, as it were, an escape of induction from the secondary circuit which is called the magnetic leakage. In discussing in a later

Primary E.M.F., Current, and Induction Curves of a Ganz Transformer at No Load.

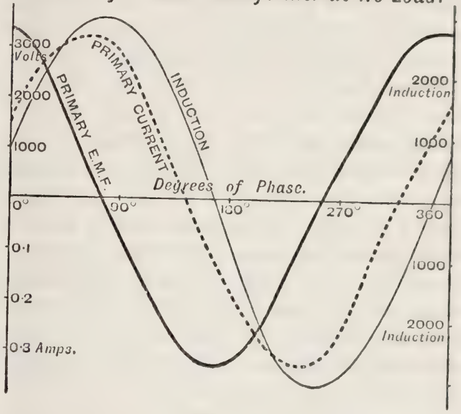

Fig. 23.

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* See "The Alternate Current Transformer," vol. i. (new edition), p. 358.

lecture the testing of a transformer, we shall consider how this quantity can be measured. Having delineated the whole of these curves for a transformer, we are then in a position to draw a hysteresis diagram for the transformer. To do this, we have to set off in the form of a cyclic curve the variation of induction with magnetising force. It can easily be shown that if we construct a closed curve, by setting off on a horizontal axis the different instantaneous values of the primary ampere turns of a transformer on open secondary circuit taken at equal time intervals during the phase, and if corresponding with these we set off the vertical ordinates representing the total induction in webers in the core of the transformer corresponding to these different values of the ampere turns, then the total area of that curve integrated in turns of a unit of area—one side of which represents a weber, and the other side of which represents an ampere-turn to the selected scale will give us the value in joules of the energy wasted in the core of the transformer in one complete magnetic cycle, and in this manner we can determine from the transformer diagram the power wasted in watts in the core when the transformer is on open secondary circuit. This power is spoken of as the iron core loss in the transformer, and it can be determined directly from the transformer diagrams. In a later lecture we shall see how it can be more conveniently determined by one single direct measurement with the wattmeter. The diagram in Fig. 24 shows the hysteresis diagram thus determined for a Ganz transformer.

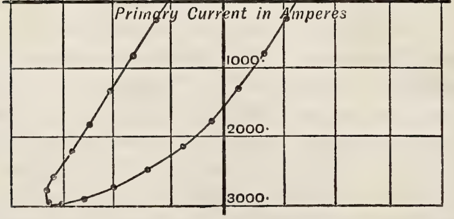

FIG. 24.

We have now briefly reviewed the chief actions going on in the transformer. Let us sum them up. If we apply to the terminals of a transformer a periodic electromotive force varying according to any law, we find that we have a peric current set up in the primary circuit which l behind the primary electromotive force when transformer is an open secondary circuit, which gradually comes into step with it proportion as the transformer is loaded up. good closed circuit transformers a very sr amount of loading up—even as much as c fiftieth of full load—will suffice to bring primary current curve into step with primary electromotive force curve. Secon we have a periodic magnetic induction in core, which differs in phase, both from primary current and the primary electromo force; and it is found that this magnetic duction curve is always a more regular cu than the curve of primary electromotive fo When the curve of primary electromotive fc is approximately a simple periodic curve, t the curve of induction is more nearly a sir sine curve. Thirdly, we have a curve secondary electromotive which is similar form to, and exactly opposite in phase to, curve of primary electromotive force when transformer is on open secondary circuit, when it is sending a small secondary curr into a non-inductive resistance. If the seco ary circuit of the transformer is practic non-inductive, as it is when the transforn is working upon a load of incandescent lam then the curve of secondary current is alw in step with the curve of secondary elect motive force, and can be deduced from Lastly, we have a curve deduced from curve of induction and primary current of load which give us the hysteresis curve of transformer. The curve of primary curren no load is generally spoken of as the m netising current, and the total power taken in the iron core in watts is spoken of as iron loss of the transformer.

General Notes.

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TRACTION ENGINES.—The Select Committee Traction Engines on Roads have agreed on t report. They recommend that there should b uniform annual licence duty of £10 on trac engines not exceeding ten tons, increasing by £2 every ton above this weight. They also propose traction engines should be allowed to pass thro other counties than that for which they are licen on payment of a registration fee of 2s. 6d. Ot recommendations were made as to the attenda upon the engines, and relaxing some of the rest tions; the increase of the limit of speed to th miles per hour, and other changes, with the objec rendering the existing restrictions less onerous.

Journal of the Society of Arts.

No. 2,278. Vol. XLIV.

FRIDAY, JULY 17, 1896.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the othergill prize of £25 and a silver medal for paper on "The Best Means of Effectually reventing the Leakage of Current to Earth in lectrical Installations from Generating Heat nd Setting Buildings on Fire." The paper ould consist of about eight thousand words, nd be written with a view to being read nd discussed at an ordinary meeting of the ociety.

Papers submitted for the prize must be sent o the Secretary on or before 1st of October, 896. Each paper must be typewritten, and ear a motto, the name of the writer being nclosed in a sealed envelope with a similar otto. The judges will be appointed by the ouncil.

The Council reserve the right of withholding e prize or of awarding a smaller prize or naller prizes, if in the opinion of the judges o essay deserving the full award is sent in.

RIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are repared to award, under the terms of the enjamin Shaw Trust, a Gold Medal, or a rize of £20.

The medal, under the conditions laid down y the testator, is to be given "For any disovery, invention, or newly-devised method for viating or materially diminishing any risk to fe, limb, or health, incidental to any indusial occupation, and not previously capable of ing so obviated or diminished by any known nd practically available means."

Intending competitors shall send in descripons of their inventions not later than the st December, 1896, to the Secretary of the ociety of Arts, Adelphi, London, W.C.

The Judges will be appointed by the ouncil.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

CANTOR LECTURES.

ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. Fleming, F.R.S.

Lecture II.—Delivered January 27, 1896.

The Construction of the Transformer.

In the previous lecture we have examined the general facts connected with the action of the transformer, and we have next to consider questions of transformer construction. The three organs of a transformer being the primary and secondary circuits and the iron core, the constructive problem is reduced to winding these circuits on the core, and properly constructing that core to receive them. We will consider, in the first place, the manufacture of the core. This has to be built up of iron wire or sheet iron, so divided or laminated that eddy currents cannot be set up in it. If it were not for this lamination, the periodic change of induction taking place in the core would set up in the mass of the metal local electric currents which would dissipate energy. Mathematical investigation has shown that, for frequency of 100, or thereabouts, it is useless to make the iron—whether in the form of wire or sheet—less than 1-100th of an inch in thickness, that is, about one-quarter m.m., and useless to laminate it all, unless the laminations are less than 1 m.m. in thickness. You will find in the *Electrician*, vol. 28, pp. 599 and 631, investigations by Prof. J. J. Thomson and Prof. Ewing, which deal elaborately with this matter. I have found that their rather complicated formulæ are not fitted for use in the workshop, but that they can, for all practical purposes, be replaced by a much more simple formula, which furnishes all the necessary information for transformer core construction. In the case of good sheet iron, and for the range of induction usually employed in transformer work, which is not more than 3,000 or 4,000 C.G.S. units, that is to say, 30 to 40 microwebers per square centimetre, if we represent the eddy current loss in watts per cubic centimetre of the plates by a symbol, E; and if we call t the thickness of the plate in mils., that is, in thousandths of an inch, and if B is the maximum value of the induction per square centimetres in C.G.S. units, and n the frequency, then it can be shown that very approximately $E = \left(\frac{t\,n\,B}{10^8}\right)^2$. Although this is a hybrid formula, containing units of different kinds, and may be horrible to purists, it will nevertheless be useful in the drawing office, and we can simplify it still more if we reckon the maximum induction in webers, and call I this induction per square centimetre, then $E = (t \; I \; n)^2$. In some works it is the custom to reckon the induction per square inch, instead of per square centimetre, and the thickness of the plate in fractions of an inch. If $t_{,}$ is the thickness of the plate in inches, and $B_{,}$ the induction per square inch, and $E_{,}$ the eddy current loss in watts per lb. of plates, then $E_{,} = \frac{1\cdot4}{10^{10}} \, t_{,}^2 \, n^2 \, (B_{,})^2$. The general custom is to use plates for transformer construction of about ·014 inch in thickness, and the standard induction which is generally selected is 2,500 lines of induction per square centimetre, or 2,500 C.G.S. units. This is equivalent to 16,125 per square inch. Under these circumstances, by the above formula it is shown that the loss in watts per pound of plates due to eddy currents would be ·07 watt; the frequency being 100. It may be noted that any increase of temperature as the transformer is worked, by increasing the resistance of the iron tends to diminish the eddy current loss. It will, therefore, be seen that by employing plates of a thickness not greater than 14 mils. eddy current loss is reduced to a very small amount. One point, however, to which your attention ought to be called is, that unless the iron plates are properly arranged, eddy current loss may exist in them, however thin they may be. If, either by reason of magnetic leakage, or any other disposition of the magnetic induction, lines of magnetic induction move through the iron in such a manner that their direction is not always parallel to the direction of the lamination of the iron, then, under those circumstances, eddy currents may be set up in the core, which are not hindered by lamination. This source of waste was present in many of the earlier forms of transformer. In addition to the loss of energy caused by eddy currents in the core, there is, of course, that other source of loss called the hysteresis loss, which is d to the magnetisation and de-magnetisation the core, and to the fact that the induction not in step during the whole period with t magnetising force, but lags behind it. T investigations of Steinmetz have shown th the hysteresis loss in iron sheets can be rep sented by a simple empirical formula whi fits the facts fairly well. It is found that t hysteresis loss per cubic centimetre per cy in the iron is related to the maximum value the induction during the cycle by a simp exponential law, and may be, for all practic purposes, closely expressed by the followi formulæ:—

Let H = hysteresis loss in watts per cub centimetre,
and H^1 = hysteresis loss in watts per lb.,
then $H = \eta \, n \, B^{1\cdot55} \, 10^{-7}$
$= \cdot0032 \, n \, B^{1\cdot55} \, 10^{-7}$.

Where n in the above formula is the frequenc and η is a co-officient called the hysteret constant, which depends upon the nature the iron. The value of η may vary from ·002 t ·005. If we reckon the hysteresis in watts p lb., then we have—

$$H_{,} = 0\cdot88_{n} \, (B^1)^{1\cdot55} \, 10^{-9}.$$

where $B_{,}$ = induction per square inch.

The exponential constant may vary from 1·5 to 1·6. Thus, for example, if $n = 100$, and $B_{,}$, the induction per square inch = 16,12 corresponding to induction per square cent metre of 2,500, then $H_{,}$ = ·29 watt per lb and H = ·005 watt per cubic centimetre These formulæ have been deduced from ex periments made with various kinds of trans former iron; and although they are empirica formulæ, in the sense that they are not deduce from first principles, yet, nevertheless, the are exceedingly useful, and agree so well wit experience, that they enable us to calculat the hysteresis loss at any one induction, whe we know it at another. We may, therefore put together the two expressions obtained fo the eddy current loss of the hysteresis loss i iron, and state that, for all practical purposes and within the limits of the induction usuall employed in transformers, the total energy los in the iron, made up partly of eddy curren loss, and partly of hysteresis loss, may be ex pressed as follows:—

T = The loss per watts in cubic centimetres
$T_{,}$ = The loss in watts per lb.; then

$$T = \cdot0032 \, {}_{n}B^{1\cdot55} \, 10^{-7} + \left(\frac{t \, {}_{n}B}{10^8}\right)^2.$$

$$T_{,} = \cdot0\cdot88n \, (B_{,})^{1\cdot55} 10^{-9} + \frac{1\cdot4}{10\cdot10} (t_{,} \, n \, B_{,})^2.$$

Vhere B is the maximum induction in C.G.S. nits per square centimetre, and B_1 per uare inch.

The curves in Fig. 25 show the variation of ysteresis and eddy current loss in plates of arious thickness for a maximum value of the duction of 4,000 C.G.S. units calculated from e formulæ of Professor J. J. Thomson.

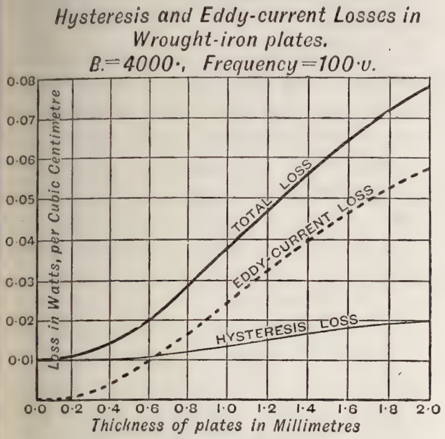
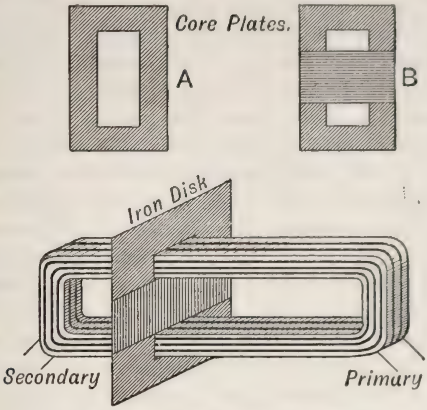


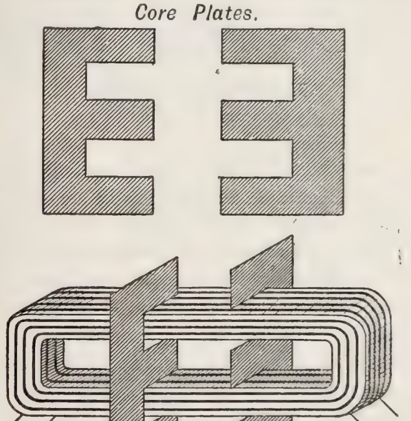
FIG. 25.

My own experience is that these formulæ gree very well with experience and with the sults of measurement. I made some years go a careful study of the old form Ferranti ansformers, and found a very fairly close greement between the results of measurement f the core loss in these transformers and the sults obtained by calculation from the above rmulæ. In specifying for iron for use in ansformers, it is now the custom to adopt a andard induction of 2,500 C.G.S. units, or nes of induction per square centimetre; that to say, the standard induction is 25 microebers per square centimetre—and the standard equency is 100. Under these conditions a ood transformer iron ought to have a ysteresis loss, varying from ·25 to ·5 watt er lb. It is possible, under some conditions, get iron with less hysteresis loss than this, ut, as we shall see presently, there are some ifficulties in keeping it in this condition. aving selected the iron, the next thing is to amp out the core plates, and afterwards to arefully anneal them. It is now well under- ood that the slightest tooling or handling of on after it has been annealed hardens it, and ises its hysteresis loss—hence the greatest are has to be taken that the plates are not amaged after annealing. The plates have en to be insulated to keep them from electric ntact with one another. The old practice was to insulate the plates with thin paper, but paper takes up too much space, and it is now usual to paint the plates with an insulating paint or varnish, which, however, must be able to withstand, without deterioration, the highest temperature which the transformer may reach in work. Even using varnish, the varnish takes about 10 per cent. of the space of the iron. In selecting the iron for the core plates, it is more important to choose an iron with small hysteresis loss than large permeability. These two things are not necessarily connected together. The number of devices which have been adopted for cutting the iron into the core plates, as to avoid unnecessary waste of metal, is very large. In Fig. 26 is shown the manner of building up the core of a Mordey transformer. In Fig. 27 the mode of building up a



Mordey's Transformer.

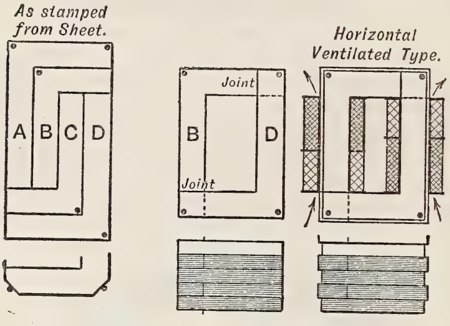
FIG. 26.



Westinghouse Transformer.

FIG. 27.

Westinghouse transformer is also shown. In this case, as in that of the Mordey transformer, where a cross piece is used, or where there are overlapping iron plates, it is customary now to use packing pieces of sheet iron to fill in the levels, and to get as much iron as possible into the space. In Fig. 28 is shown the method of stamping the core plates from the sheet and constructing the Scott and Addenbrooke transformer. The iron core having been constructed in such a manner as to afford a completely closed iron circuit for the lines of induction due to the magnetising force of the primary coil, the core is then covered with shellaced calico and mica, in order to insulate it from the primary coil; and the greatest care ought to be taken in this respect, because it is not sufficient to insulate the coils of the transformer from one another: they must both be insulated from the core. Thin ebonite is often used as a material for insulating the core, and an indiarubber compound called woodite is a very good material to use. The primary and secondary coils are generally wound on formers; they must be insulated from each other by ebonite or mica, and the primary and secondary coils should be so overlayed or intermingled (as shown in Fig. 29, which represents a typical closed iron current transformer) to avoid producing magnetic leakage. In large transformers it is customary to leave a space between the high and low tension coils for the purpose of ventilation, and in the same way air spaces or ventilation spaces have to be left in the iron core. The primary and secondary coils are sometimes separated from one another by a metal shielding plate, which is connected to earth. This is, however, not so good a plan as an effectual separation of the primary and secondary coils by an insulating shield. In the design of the core it is important to reduce the reluctance of the magnetic circ as much as possible, in order to produce large power factor. The term " power facto is defined as the number representing the ra between the true power taken up in the c to the product of the primary potential diff ence and the primary current (root - me square values being understood). This prod is called the *apparent power* taken up in t core.



Transformer. (Scott).

FIG. 28.

We shall consider in a later lecture the d advantages of a small-power factor. Mea while, it may be said that a small-pow factor in a transformer, when taken at secondary load, is always an indication large magnetic reluctance in the magnet circuit, and hence open iron circuit tran formers have always small-power factors. Tl primary and secondary coils, having be placed upon the core and insulated from on another, the transformer is put into an iro case, which is constructed to be watertight Many manufacturers include in the same cas porcelain plates or terminals, to which the attach the extremities of the primary an secondary coils. This, however, is not s good a plan as connecting by a highly insu lated joint the extremities of the primary an secondary coils to highly insulated cables which are brought out through watertigh glands in the iron case, any necessary connections to fuses or switches being then made outside. In the design of large transformers, one important consideration is getting rid o the heat. A transformer ought never to rise above 100° Centigrade under any conditions of use, and for every watt which is lost in hysteresis, and by copper resistance at least 3 to 4 square inches of cooling surfaces must

Typical Closed Circuit Transformer.

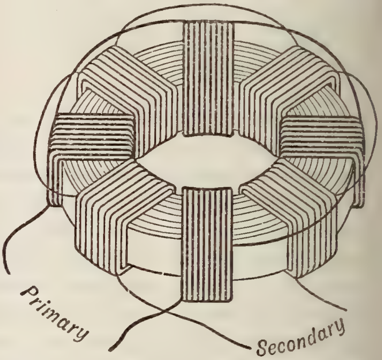


FIG. 29.

provided. In the case of very large sub-tion transformers, it has even been found vantageous not only to leave ventilating aces in the core, but to force a draught of · through the transformer to keep it cool. In me cases a highly insulating oil is put into e case, but the insulation of the transformer ust be good enough to work without it. The e of the oil is merely to keep out damp r, and even then it is not always successful preventing break down. The notion that could be used as an insulation for trans-rmers, which would heal up again after e passage of a spark or arc, was not nfirmed by experience. As regards the neral design of transformers, the battle of en versus closed iron circuit transformers as fought out and decided long ago. Open rcuit transformers—such as the hedgehog ansformer—have no advantage over the osed iron circuit transformer in respect of re loss per kilowatt output, and they have a cided disadvantage in a smaller power factor. oreover, in a closed iron circuit transformer, the transformer is loaded up, the power ctor very soon reaches unity; the curves in ig. 30 show the manner in which the power ctor of several different types of transformer ries as the transformer is loaded up. In a od closed iron circuit transformer, with nall magnetic reluctance, a very little ading of the secondary circuit brings the wer factor up to unity. In the case of a kilowatt Mordey transformer I found that, ading up to 1-60th of full load, brings e power factor up to unity. The advantage large power factor means that we have a nall root-mean-square value in the magnetising current at no load, and, therefore, a small heating loss in the main supplying the current of that transformer. When the transformer is at work we not only have energy losses going on in the iron, but, at the same time, we have energy losses in the copper, called the copper losses, which are due to the resistance of the copper circuit. It can be shown the most advantageous ratio between the copper losses and the iron losses is to so construct the transformer that at full load the total copper losses are equal to the total iron losses. In very large transformers, where the secondary circuit consists of very thick copper bands or wire, if magnetic leakage exists to any sensible extent, we may have eddy current losses set up in the copper circuits, and this, in addition, may be a source of energy waste. The copper resistance operates not only to cause a large energy loss, but partly to account for what is called the secondary drop of the transformer. If a transformer is connected to a constant potential primary circuit, and if the secondary circuit is gradually loaded up, the potential difference between the secondary terminals is less when the transformer is fully loaded than it is when the transformer is on open secondary circuit. This difference is called the secondary drop. This drop is due to three causes—firstly, the resistance of the primary circuit; secondly, the resistance of the secondary circuit; and, thirdly, to magnetic leakage. As far as regards the copper resistance, we may calculate the secondary drop by the following formula :—

$$\text{Secondary drop} = \left\{ \frac{100 \times (C_1 - \textit{mag. cur.})\, R_1}{E_1} + \frac{100 c_2\, R_2}{E_2} \right.$$

Where C_1 is the R.M.S. of the primary current.
C_2 is the same value for the secondary current
R_1 is the resistance of the primary circuit.
R_2 is the resistance of the secondary circuit.
E_1 is the difference of potential between the primary terminals.
E_2 is the difference of potential between the secondary terminals

taken when the transformer is on open secondary circuit, and the symbol *mag. cur.* stands for the magnetising current of the transformer, that is, the primary current when the transformer is on open secondary circuit.

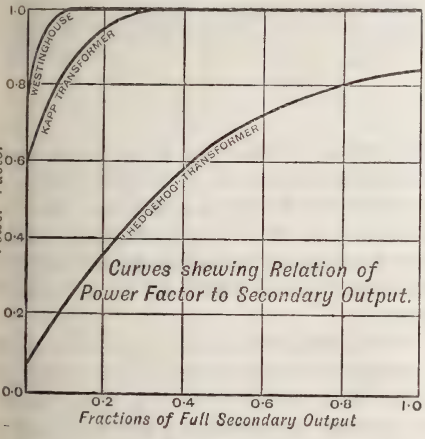


FIG. 30.

This formula, however, only gives us that part of the drop which is due to the copper resistances; the actual observed drop would be greater than this by an amount due to magnetic leakage.

In dealing with the testing of transformers in our next lecture, we shall discuss the method by which this drop may be measured. In considering the action of transformers, it is important to notice that the iron core loss of the transformer, the secondary drop, and the power factor of the transformer at no load, are all greatly affected by the form of the curve of primary electromotive force. It is the custom sometimes to speak of the core loss of a transformer as if it were a quantity inherent in the transformer itself, and which could be exactly specified for any particular instrument. As a matter of fact, this is not the case. Experiments carried out with different transformers worked on different alternators by Dr. Roessler in Germany, and by myself in England, have abundantly demonstrated that the form of the curve of primary electromotive force has an immense influence on all the above-mentioned quantities. Dr. Roessler employed two machines—one a Wechsler and the other a Ganz alternator. When these machines were running on open circuit, the Wechsler alternator gives a curve of electromotive force which has a well-rounded form; whereas the Ganz machine has a curve of electromotive force which has a very sharp peaked form. The machines I chiefly e ployed in my own experiments were t Mordey alternator, the Thomson - Houst alternator and a Ferranti machine. The fo of the curves of electromotive force of the fi two named machines, under various conditio have been shown in Lecture I. The gene effect of all these experiments has been demonstrate that when a transformer is work off an alternator giving an electromotive for curve with a very sharp or peaked form, t effect of this is to make the iron core loss *les* and the secondary drop *greater* than it is the same transformer is worked off an alte nator having a curve of electromotive for with a rounded or square-shouldered form. I therefore, we draw an efficiency curve for transformer, that efficiency curve giving t efficiency—that is to say, the ratio betwe the watts delivered from the secondary to t watts taken in on the transformer circuit—an express this efficiency in terms of the fractio of the secondary load of the transformer, t form of that efficiency curve will be affected b the nature of the machine which is supplyin the primary current. In Figs. 31, 32, 33, ar shown curves illustrating the effect of the employment of different alternators on the sam transformer in affecting the efficiency, primar current values and secondary drop of any give transformer, when taken on open seconda circuit.

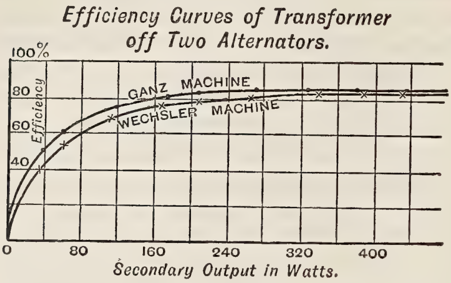


FIG. 31.

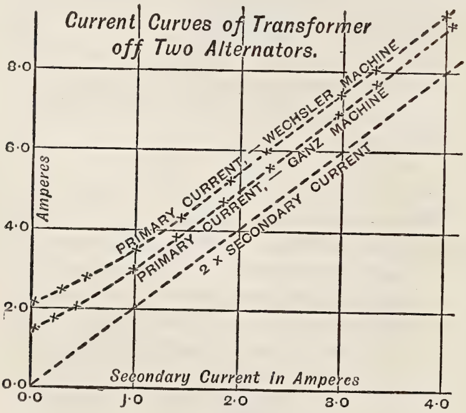


FIG. 32.

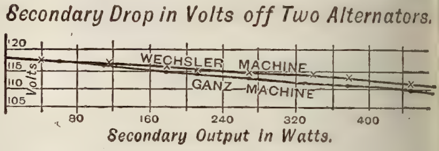


FIG. 33.

For fuller information on this point the reade is referred to the treatise on the "Alternat Current Transformer"* (vol. I., chap. vi., ne ed.), by the present writer, which will suppl more details on this question than we hav space to consider here.

Miscellaneous.

CULTIVATION OF VANILLA IN MEXICO.

The following information on Vanilla is taken from Sir Henry Dering's report on the productions of exico, already referred to :—Vanilla is found grow- g wild in many districts of Mexico, and it is culti- ted in Michoacan, Puebla, Oaxaca, Tabasco, Vera uz, and other places. There are six varieties of nilla known in Mexico, namely the "mansa," the imarrona," the "mestiza," the "pompona," the uerco," and the "mono." Of these the mansa d the pompona are cultivated. A rich vegetable l, such as is found in the dense forests of the erra Caliente, is best for vanilla cultivation and owth, and in such localities the vine grows luxuri- tly, and gives a large pod. The months of June d July are considered in Vera Cruz and Tobasco most appropriate for planting, and the plants will mmence to flower in the second year after planting, d full crops may be expected between the third d fourth year. The flowers appear in March, ril, or May in clusters of 20 to 50. The fruit goes growing for a month, but it will take at least ht months longer to ripen sufficiently for harvest- g. The proper time for the ripening of the vanilla the districts of Tuxpan, Misantla, and Papantla is the months of January, February, and March. e bean, if allowed the necessary time to ripen operly, is black and juicy, and, when well prepared, ll keep good for many years, but, if gathered before turity, is bound to be defective. After the beans gathered, they are plunged for half a minute into t water that is almost boiling. They are then put mats to drain dry, and afterwards are spread out blankets and exposed to the sun, and in the even- g they are shut up in tight boxes to ferment. The x in which the vanilla is to be sweated must be t in the sun during the day to warm it, and it must big enough to hold all the vanilla that has been read out. The sunning process is continued for a ek, or until the pods become brown and pliable, en they are squeezed between the fingers, to aighten them, and to cause the seeds and oily sub- nce inside to be evenly distributed. After the erator is satisfied with his work of sweating, the nilla beans are then separated into sizes of length, ckness, colour, and appearance. The Mexican nilla dealers have established five grades, namely : First, vanilla "fina," or "legal," the beans or ds from 6½ inches long or upwards, short in the ck, sound and black; the beans which become lit or open, provided they have the foregoing alities, and the split does not extend more than a rd of the pod. This class is again subdivided o "terciada," which is composed of the shortest ds; "primera chica," "primera grande," "marca nor," and "marco mayor," the largest of all. cond, vanilla "chica," those pods which differ ly from the terciada, in being shorter, two of them unting as one of the first-class. Third, vanilla zacate," the pods of all sizes, which are off colour ough being gathered before becoming ripe or being er cured, "pescozuda," "vana," "cueruda," and poscoyonada," names for pods in a more or less maged condition. Fourth, vanilla "cimarrona," the wild vanilla, in good or fair condition, three pods counting as one of the first-class. Fifth, the "rezacate," composed of the very short pods, of those split clear up to the stalk, of the badly damaged, of the very immature, and of the very much overcured. After the sizing and classification is finished, the pods are tied up in bunches of 100 to 150, so as to weigh one pound, and wrapped up in paper and tinfoil. Statistics show that there is more vanilla exported from the port of Tuxpan than from any other port in the world, thus establishing the fact that the Tuxpan valley is the natural home of this valuable orchid. As much as 300 per cent. profit has been made in good years by those engaged in the vanilla industry in Mexico.

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* "The Alternate Current Transformer in Theory and Practice." 2 vols. The *Electrician* Printing and Publishing Company, 1, Salisbury-court, Fleet-street.

THE UTILISATION OF POWDERED COAL.

Some years ago, Herr Carl Wegener, a German engineer, brought out a new process for utilising powdered coal. It is based on the principle that coal cannot be thoroughly burnt unless each particle is surrounded with sufficient oxygen to ensure perfect combustion, and this can only be effected by first reducing the coal to powder. According to Kuhlow, analyses of the gases of combustion prove that there is much more perfect combustion with the new method of firing with powdered coal than with large coal. The previous invention of Herr Wegener was tested about two years ago at the Nord-Deutsche Lloyd's Works at Bremen, and very successful results were, it is said, obtained. Herr Wegener set to work to simplify his invention, and has now produced an apparatus in which the chimney draught alone supplies the required current to admit the powdered coal mixed with the required quantity of air into the firebox. The advantages claimed for the invention are :—An economy of coal of at least 20 per cent., and saving of labour as the powdered coal is fed automatically; one man can easily attend to four or five boilers, and as there are no doors to open, he is exposed to little heat; combustion is practically perfect, and each particle of coal is reduced to a white incandescent heat, there is no smoke from the chimney, and no fire bars, door or grate. The following is a brief description of the system. The small sacks of powdered coal weighing about half a hundredweight are put into a conical hopper; the powdered coal gradually falls out of the sack, as required, into the hopper, and then on a sieve about 5½ inches in diameter, with small openings in it. The powdered coal would not go through this sieve, with certainty, without continued tapping, and this is done in the following manner. Immediately beneath the hopper, and level with the boiler-house floor, is an air-pipe about 20 inches in diameter, through which nearly all the air for combustion enters. As it enters it is made to pass through the blades of an air wheel or turbine, and this passage of the air causes the latter to revolve like a smoke-jack. On the axis of the air-wheel there is a little knocker, which taps the sieve about 150 or 250 times per minute, causing the powdered coal to descend vertically through the sieve, meeting the air for combustion as it falls. The powdered coal and air for proper combustion in this way get mixed thoroughly together, and pass on into the boiler flue, each particle of coal being surrounded by air. There is no grate, and there are no fire doors, and the stoking simply consists of putting a sack of powdered coal from time to time into the top of the hopper, and seeing that the right amount of air is going in for combustion. If there is not sufficient air for proper combustion entering through the main opening, as seen by a little smoke, there are two other smaller pipes, where additional air can be admitted, each kind of coal requiring a somewhat different amount of air. The only object of the air-wheel revolving, from 50 to 80 revolutions per minute, is to shake the sieve and cause the powdered fuel to go into the furnace in the quantity desired. When more steam and coal are required, a sharper knock is given to the sieve, and more powdered coal is burnt; when less is required, a slighter shake is necessary. A screw adjustment for knocking is provided to regulate the amount of coal entering, which is done by turning a half-inch thumb-screw. The only duty of the attendant is to put the sacks of coal into the hopper, and he ascends a short ladder to do this. He also has to regulate the amount of air for combustion, and then there is no smoke.

CIDER IN FRANCE.

The following article from the *Economiste Français* is taken from the *Board of Trade Journal*:—

The year 1895 has been a good one for cider manufacturers in France, the amount produced having risen to 25,586,514 hectolitres, or an increase of 11,803,785 hectolitres over the average of the last ten years, that is, also including the year 1893, which was quite an exceptional one, the production then having attained the extraordinary total of 31,600,000 hectolitres. The most characteristic feature of the year 1895 is, however, not so much the total production as the sale of apples. German agents have been literally emptying Normandy and Brittany of fruit, no longer by vanloads, but by entire trains. Official statistics are silent on this point; but it will be shown later on what use the Germans have made of these millions of apples which they have manufactured into sparkling cider and "champagne." It may not be devoid of interest to glance at the average production of cider according to the various departments. Ille-et-Vilaine leads with an average of 2,520,658 hectolitres; in certain years it reached 6,000,000; Calvados follows with 1,320,890 hectolitres; La Manche, 1,170,520 hectolitres; Cotes-du-Nord, 1,069,274; Orne, 1,033,388; Seine Inférieure, 933,388; Morbihan, 825,202; and Eure, 932,552 hectolitres; Mayenne, Sarthe, Oise, and Loire Inférieure each show an average production of f 339,000 to 539,000 hectolitres.

The country between Vimontiers and Arger and the district round within a radius of 20 leag is where the best kinds of cider are produced; for the peasants of these districts the apple, w there is an abundant supply, is an important arti In good years, and when attention is paid to cultivation, the apples alone will pay the rent, notwithstanding the irregularity of the harvests, rare that the Norman peasant cannot turn ou sufficient quantity of cider for his family and ho hold, who together consume no inconsiderable amo

It is as the result of long and patient experim that certain parts of France have become the pren cider-producers of the world.

Normandy was the first to popularise cider drink. Thence it spread to Picardy, Flanders, many, Russia, England, and finally to Amer Ever since the 14th century the Norman juices h been the most celebrated, and even to-day her ci are considered the finest in the world.

The nature of the soil has doubtless much to with the excellence of French ciders, but science art have also lent their aid, and it is only by din care and repeated analysis that producers have arri at this point of perfection. What strikes the att tion, when this question of cider is studied in details, is the incredible variety of apples concer in its production. M. Fabius de Champoille, has just published a complete essay on the cultivat of the apple, and the manufacture of cider, drawn up a catalogue which enumerates seve hundred varieties of apples. From this treatise appears that acid apples (*pommes acides*) give abundant, clear, and light juice, and the cider wh is made from them is liable to turn black, and it generally weak and difficult to keep. Sweet app (*pommes douces*) also give a clear cider which agreeable to the palate as long as it is new, but soon as the sugar is absorbed it ferments and g sour, and contracts a bitter taste which renders unpleasant as a drink.

Another kind of sweet apple (*pommes sucrées*) g as clear a liquid as the preceding, but the presence a quantity of alcohol in the sugar renders it strong and better adapted for keeping. Finally, bitter sour apples (*pommes amères ou âcres*) give the m generous cider, which is of a fine colour, and kee well. The cider obtained from a blending of bitt or sour with sweet apples, though it keeps rath less well than the preceding, is lighter, and mo agreeable to drink. With regard to the time of ye at which they ripen, apples are divided into thr categories:—The apples of the first season, ripeni in the middle of September; those of the seco season, which ripen in October; and those of t third season, called late apples, which are gather in the last fortnight of October or the first vember. After sugar, tannin is the most ortant constituent of an apple, and it plays *ôle* of incontestable utility.

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* "Comment s'obtient le bon cidre." Paris. "Socié d'editions scientifiques."

t is very difficult to state exactly what is the value ider produced in an average year, because prices n vary according to the district and according to quantity and quality of the production. Speak- generally, the price of cider reaches, in the artment of the Orne, 15 francs per hectolitre for ordinary harvest. Certain years, when apples are , it may amount to 20 and 22 francs per hecto- e; but the average price of the whole production y be set at about 10 francs per hectolitre. Taking output at 20,000,000 hectolitres, the value is de out to be 200,000,000 francs; and this is only average, since the production for 1895 was only 000,000, and that of 1893 more than 31,000,000 tolitres. In this figure is not included the pro- tion of apple spirit, which reaches an average from 60,000 to 70,000 hectolitres.

Iere, then, is an important source of public alth, taking into consideration that the production oncentrated into a very few districts. But it may asked if French producers know how to get the nost possible from the resources of the soil, and if, h greater industry and care, they could not terially increase the output of the apple orchards. e events of last year would seem to show that re is much to be done. Why should Germany, ich consumes very little cider, buy up Normandy les in such large quantities? The reason appears be that the Germans know well how to profit by nch products. They have become the suppliers England and America, and extracting much cider m French apples by an addition of water, they are e to export annually millions of bottles from men and Hamburg to London and New York. addition, with the help of certain chemical pro- ts, a sort of sparkling sweet beverage is manu- tured, which is known as "German champagne."

The manufacture of cider in Germany is not an air of yesterday. French Consuls have frequently led the attention of the Government to the im- tation of French apples through the frontier vns. In 1892, M. Henri Belle, French Consul- neral at Frankfort, informed the French Govern- nt that the city of Frankfort alone had received ring the year 1891 1,417 waggon loads of cider les. During the following year this movement l become so considerable that the same Consul ught fit to draw up a special report on the estion, in the course of which he said:—

'Cider factories, which increase every year, are w in full activity (1892). The number of work- n employed in this industry is constantly on the rease, and may now be estimated at 1,190, the rly value of the production of this industry, ich contributes so much to the town's properity, ng calculated at from 12,000,000 to 13,000,000 of ncs. Frankfort, which has five large cider factories, l 45 of less importance, consumes but a small part of its production, the principal outlets abroad for this article being, in the first place, Turkish ports, and then Athens, Damascus, Aden, Calcutta, Sydney, Cape Colony, New York, Baltimore, San Francisco, Buenos Ayres, and even Pekin. The two agencies for Frankfort cider, recently established in London, are doing excellent business."

It may be added that the chief cider factories of Frankfort had established, at the Chicago Exhibition, bars, where the German product could be sampled.

At the present time France exports, on an average, barely 13,000,000 hectolitres of cider, while Germany, who hardly grows any apples at all of her own, exports 10 times as much, and at very high prices. From this point of view, syndicates for production and sale can work with the best results. The Norman producer, left alone, is powerless to create fresh outlets; he depends upon a forcedly restricted local market, and is incapable of attacking foreign markets, and occupying himself with the sale of his products abroad. The *rôle* of a syndicate is a double one; on the one hand they create fresh outlets by organising a service of correspondents and sales abroad, and on the other hand by guaranteeing with their responsibility the quality of the products given over for consumption. Already certain well administered syndicates have been organised in several districts for the sale of cheese, fruit, wine, and cider, and their efforts have been crowned with success.

The agricultural and horticultural syndicate of Ille-et-Vilaine, for example, founded at Rennes, in 1886, now numbers 1,500 members. This syndicate has for its especial object the acting as intermediary for the purchase and sale of manures, agricultural and horticultural products, and machinery, farm animals, grain, and seeds; for facilitating the sale of farm products, chiefly grain, cider, milk, butter, fruits, seeds, farm animals, and all products of cultivation. In 1893, the syndicate did business to the value of 70,000 francs in phosphates, chemical manures, forage, seeds, and agricultural machines. The Calvados Syndicate in May, 1892, tried the experiment of direct sale of all agricultural products, and the idea rapidly made its way. This system consists in the dispatch of samples of the products. The producer advertises in the bulletins of the various syndicates what products he has for sale, indicating the price, and, at the same time, affording the consumer a chance of himself reckoning the value of the product, by sending him a sample by parcels post. These are, however, but a series of attempts; much yet remains to be done to satisfy all the demands of producer and consumer.

It is not, however, only from the point of view of sale that the agricultural syndicates can render good service; their action may extend to the cultivation and care of the apple trees and the manufacture of cider. To orchard proprietors they could give valuable advice on the choice of species, on the quality of grafts, and on the means of destroying the parasites which, like those of the vine, devour the crops and ruin the trees; and they could indicate to those interested the best kind of apple-press and methods of manufacture, which, it is said, still leave much to be desired. In fact, an almost unlimited field of activity is here opened up to the agricultural syndicates, who have already done such good service and will do more still, if their spirit of initiative be not checked.

PRODUCTION OF SUMATRA TOBACCO.

The United States Consul General at Singapore, in his last report, calls attention to the great increase that has taken place in the production of Sumatra tobacco, and the high price it commands on account of its superiority, especially for wrapping purposes, and he gives some interesting particulars of the origin and growth of the industry. It was in the year 1862 that an Arab drew the attention of a commercial house in Batavia to the district of Deli, on the east coast of Sumatra, a country where pepper and tobacco were being produced, and where a good market could be found for European goods. This led to a commercial expedition to Deli in March, 1863, which expedition was joined by a tobacco planter from Java, with the special object of inspecting the soil in Deli, and seeing whether it was suitable for tobacco cultivation. The result of this expedition was that the planter in question obtained a firm footing in Deli, and being provided with the necessary funds by a firm in Rotterdam, he sent his first 50 bales to Europe in 1865, and in 1866, 189 bales. This tobacco attracted the attention of experts, and it was decided by a group of financiers in the Netherlands to embark capital in the enterprise. This was done, and a company was established in November, 1869, with a capital of 300,000 guilders. This is how the Deli Maatschappy was started—the pioneer tobacco planters in Deli. The tobacco crop from the east coast of Sumatra, which, since 1869, had been gradually increasing, reached a total of over 236,000 bales, of 174 lbs. each, in 1890. This was too large a crop for the consumption, for heavy loss was sustained by planters, many of whom, working with slender means, had to close their estates, and even the Deli Maatschappy suffered a loss that year. In 1891 the crop was about 10,000 bales less, and prices improved, but although the big companies made comparatively small profits, many private planters had to close. This reduced the crop of 1892 to about 150,000 bales, which brought good prices, and evidently stimulated the production, for the crop of 1893 rose to 160,000 bales, and the 1894 crop was estimated at 200,000 bales or more. Consul General Pratt says that, as far as he has been able to gather from the means at his disposal, there are at present on the east coast of Sumatra, 26 public companies and about 25 private planters engaged in tobacco cultivation. As to the method of cultivation, the planting is done by Chinese coolies, imported chiefly direct from China. When the number from China proves insufficient, Chinese are engaged ir Straits Settlements on contract. Each Chi coolie gets a field of three-fourths of a b (1 bouw = 1¾ acres). He has to plant tob on the field, and he gets payment for his la when the tobacco is ripe and delivered by him t master. When he delivers his tobacco, the coo paid per 1,000 plants, according to quality, from dollar to eight dollars. During the planting sea however, he receives an advance equivalent to a £1 sterling a month. When the tobacco is in fermenting sheds, the Chinese work in the shed contract until the planting season begins again. T are chiefly employed at sorting tobacco, and rec about a halfpenny for each bundle of 35 to 40 lea Besides Chinese other coolies are employed, nam Japanese, who, at the beginning, receive about 2 month, and the women 12s. per month. They employed in road-making, shed-building and jun cutting, or clearing work. Klings are also foun Deli, but they are comparatively few, and those are there work as cattle-keepers and road-mak and earn from 25s. to 37s. 6d. per month. Plough is paid for by the month. With a plough and pairs of buffaloes, one-third of a field, or one-fou of a bouw, can be ploughed per day. A Japan or Kling gets for this about 33s. a month, and looking after the buffaloes, about 8s. 6d.

THE CULTIVATION OF THE POPPY I PERSIA.

Opium is largely produced in Persia, about 6,0 chests, each weighing about 130 lbs., are expor annually, and it is probable, says the United Sta Minister at Teheran, that nearly, if not quite, equal quantity is consumed in the country. T opium poppy is not difficult to cultivate, but to br it to a state of maturity to produce opium requi very considerable knowledge and unremitting c and attention. All Persian opium is cultivated irrigated land; consequently, the moisture is pr tically under the farmer's control. This is m important, as rain, when the plant is nearly maturity, would be certain to destroy the opi elements. The quantity of moisture has to be m carefully regulated, except in the winter, when t plant is in a kind of quiescent state and independ of external influences. The great difficulty with whi the amateur grower has to contend is to know t exact time when the plant arrives at maturity, f without this knowledge all his efforts will be fru trated. All the plants will not mature at the sa time, and each one has to be examined separately. the incision for extracting the opium is made t early in the plant, nothing but a white sap w exude, and if made too late, the juice will have dri up. The seed is sown broadcast in September a October, on a level surface, and before sowing t ground is cleared of stones and rubbish. When t d is sown, the water is turned on, and the ground allowed to remain without any further operation two or three days, until the water has become orbed, and the outer surface has had time to a little. The ground is then raked over as to make a complete covering for the d. In about six weeks from the time of ving, the plants will have shot forth four or leaves. It may, however, be two months, for weather is occasionally cool, and this retards wth. The plants are hardy, and will withstand cold up to freezing point. During the winter no gation is needed. The flowers will appear in y, and continue for about a fortnight. After the wers begin to droop, and until the opium matures he most critical time ; and a close observation of plant has to be made, so that a healthy condition y be maintained. When the flower has fallen, the l immediately below must be very carefully noted. hen it assumes a light brown colour, darker than ber, it may be assumed that the poppy has tured. An incision diagonally across the boll m top to bottom is made ; and if the juice, of a k brown colour, exudes, it is certain that the um is matured. The incision is made in the ning, and the opium which adheres to the stem of plant is removed before sunrise. In Persia the um is collected into jars or ordinary cooking nsils, and stored up at the cultivator's house, until harvest is finished. Each plant is examined ore the incision is made ; for, as mentioned above, re is a difference in time in the maturing of the nts ; some earlier and some later. The plant ens about the end of May or beginning of June, the time depends upon a variety of circumstances, hough the variations are not great. The preparan of the drug for the market is usually undertaken the merchant, and but rarely by the cultivators. is is a business quite distinct, and requires a building and utensils generally beyond the reach of the ducer. When the opium reaches the merchant, it tains a good deal of foreign matter, especially ces of the stem of the plant, to which the opium eres. These have to be removed, and then the um undergoes a process of kneading and pressing, as to get rid of the superfluous water. A little is used in the process, and some kinds are largely ited with it.

SPANISH FRUITS AND NUTS.

he climate and soil of Spain favour, to a remarke degree, the cultivation of fruits and nuts, which produced and exported in large quantities, and many are considered to be unrivalled in flavour. e most valuable product of the Spanish soil is the pe vine, which furnishes fine fruit, and yields ny kinds of wine and superior qualities of alcohol, egar, and tartar. Of all dried fruits, raisins have, n the earliest times, been the most popular, and have even served as a medium of exchange. The United States Consul-General at Barcelona says that the best known kinds are the Pasas de Denia, of which there are two varieties, and the Pasas de Malaga, of which there are three, La Moscatel, La Flor, and El Sol. There is another variety, called Pasas de Legia, which is produced by treating the grape with a liquid composed of water, ashes, and oil. In 1894 Spain exported 32,425,000 kilogrammes (kilog. = 2·2 lbs.) of raisins, and 19,763,000 kilos. of grapes, principally to Great Britain and the United States. The best Spanish oranges are those grown in Valencia, Seville, and Malaga. In 1894 the exportation of this fruit amounted to 160,340,000 kilos, principally to Great Britain, France, Germany, and Belgium. Spanish apples are of many kinds: they are grown principally in Andalusia, Aragon, in the Asturias and Provincias Vascongadas. The best known varieties are those called the Balbonis, Balsain, Oro, Coralino, Bilbao, Ripanaldas, Vizcainas, Castellanas, Romana, Encarnadas, Violadas, Doradas, Anis, Paloma, Api, Rosa, Tostada, and Helada. In the Asturias and Las Vascongadas and in Santander, cider is made in large quantities, but it is chiefly consumed where made. It is not of sufficiently good quality to export or bring into competition with the cider of other countries. The supply of pears, owing to the great variety produced, never fails in Spain during the entire year. Various liquids are made from pears by the Spaniards and with successful results. These liquids include pear vinegar, brandy, and cider, and material to mix with white wines. The melons of Spain merit all the praise they receive and that is great. Some of the best are produced in Valencia and are exported in large numbers. The people of Barcelona are well supplied with them from September until March, and they may even be had later and at very reasonable prices. As regards peaches, Spain acknowledges that the United States, France, and Italy, produce better fruit than she does, but the Spanish peaches are nevertheless not only good when preserved, but many of them are excellent when fresh. The Parvias of Murcia, Andalusia, and Almeria are considered the most excellent kind, but as a matter of fact they are, in the opinion of the Consul, rather hard. Pomegranates were brought from Africa and acclimatised in Spain in times too remote to be specified with accuracy. The favourite varieties are those of Carcogente and Jativa and the so-called Ciñuelas. They are chiefly cultivated in Almeria, Murcia, Orihuela, Valencia, Castellon, and Tortosa. In 1894, the exports amounted to 9,588,000 kilogrammes. Figs grow in all parts of Spain, but they thrive best in Alicante, Castellon de la Plana, Aragon, Catalonia, Malaga, and Valencia. The exportation in 1894 amounted to 4,156,000 kilogrammes. France, Denmark, Cuba, and Great Britain were the largest consumers. Chestnuts abound, principally in Catalonia, Vixcaya, Estremadura, and the Asturias, but they are not of a superior quality, and are not exported to any great extent. Walnuts are abundant in Cordova, Malaga, Leon, Huesca, Oviedo, and along the whole Cantabrian coast. In 1894, the exports amounted to 81,000 kilogrammes. Tarragona is the land of filberts, and most of them find their way to England. Nearly every kind of almond is grown in Spain. The Spaniards divide them into two general classes—the sweet (*almendras dulces*), and the bitter (*almendras amargas*). The former are cultivated, especially in Alicante, and are of five varieties—Pestañeta, Bale, Blancal, Mollar, and Comun; the latter are produced in Tarragona and Malaga. Perhaps the best of all the Spanish almonds are those of Malaga, which are almost cylindrical in shape, and have a very fine flavour. The exportation of almonds in 1894 was as follows:—In shells, 1,436,000 kilogrammes; without shells, 3,475,000 kilogrammes. The principal markets for Spanish almonds are Great Britain, France, and the United States.

General Notes.

INDUSTRIAL EXHIBITION AT NUREMBURG.—The opening of the National Industrial Exhibition at Nuremburg, by the Prince Regent of Bavaria, took place on Thursday, the 14th May. The Exhibition will remain open until the 15th of October next.

PRAGUE PHARMACEUTICAL EXHIBITION.—The *Journal de la Chambre de Commerce de Constantinople* states that the Pharmaceutical Society of Prague will celebrate its 25th anniversary in 1896 by an International Exhibition of Pharmacy, to be held from the 15th August to the 15th September, 1896, at Prague, and to include the following groups:—Scientific apparatus and articles used in the pharmaceutical branch, and the literature having reference to same; machinery and various apparatus serving for the manufacture of pharmaceutical articles, pharmacy fittings, &c.; products and drugs used in pharmacy; manuscript books, statistics, and tables concerning the historical development of pharmacy; associations and corporations of the pharmaceutical branch; hygiene and the care of invalids.

BUDA - PESTH MILLENNIAL EXHIBITION.—Forestry occupies an important place in the Exhibition, which was opened by the King of Hungary (and Emperor of Austria) on May 2nd last. Gigantic trunks and logs reveal the existence of oak forests. A large quantity of this fine timber is exported to foreign countries partly in the form of logs, partly in the shape of staves. Two buildings are devoted to sugar and flour manufactures, both of which are in a flourishing condition. The silkworm industry is to be seen in another building; but this has not yet reached a very advanced stage, as the silk obtained from the cocoons is not manufactured in Hungary, but is practically all sent to France and Italy for that purpose. Bosnia and Herzegovina show specimens of their home industries, confined chiefly to broidering and such like. Croatia - Slavonia their pavilion with specimens of their industrie important feature of which appears to be the tar liquid extracted from oak waste wood. The m facture of this extract was introduced into Sla by an English company.

METALLIC SAND.—The United States Cons Martinique says that there exists in that islan well as on Guadeloupe Island, an inexhaustible su of metallic sand, the concession for the remov which is held by a person residing near Françoi Martinique, near which point the deposit in island is situated. A contract may be entered to remove the sand at a low figure per ton. lots of this sand, and also two lots from Guadel were analysed in the United States sometime and furnished the following results:—Lot 1, tinique: oxide of iron, 69 per cent.; phosph one-tenth of 1 per cent.; titanium, one-tenth per cent. Lot 2, Martinique: oxide of iron 7 per cent.; phosphorus, one-thirtieth of 1 per ce titanium, 2·1 per cent. At Guadeloupe, there heavy deposit, two lots of which, upon anal showed the following:—Lot 1: oxide of iron per cent.; phosphorus, one-tenth of 1 per ce titanium, only a trace. Lot 2: oxide of iron, 6 cent.; phosphorus, one-twentieth of 1 per ce titanium, 1·25 per cent. Consul Tucker says informed that the sand at Guadeloupe can als purchased at a small figure per ton. The depo are upon the sea-shore, and can be remove lighters to the vessels. Labour is plentiful and ch

TOBACCO GROWING IN ITALY.—H.M. Co at Genoa reports that a new agency for the cult tion of tobacco has sent to the Director of Government Tobacco Monopoly samples of so-ca "Kentucky" tobacco grown in the provinces Caserto and Salerno. An agency at Lecce also samples of "Levant" quality, grown in special z of land. Results, especially in the case of the K tucky, were said to be extremely satisfactory, sh ing that indigenous culture of tobacco is capabl great advances, and that the State will be abl mix a larger proportion of home-grown leaf with manufactures, to the great advantage of distr suitable for its growth. The Kentucky leaf, es cially from Nocera dei Pagani, was spoken of large, fragrant, soft, flexible, with a very soft st and capable of becoming, to a large extent, a s stitute for American tobacco in the manufacture "fermented" cigars. The small, light-colou Levant tobacco, for cigarettes, had improved in 18 especially that cultivated on land only sligh manured and not irrigated. There seems ev reason to hope that the cultivation of tobacco Italy may assume larger developments, and Central Administration allowed that in some Gove ment factories, by way of experiment, fermen cigars, popular as "Toscani," might be made w 50 per cent. of native leaf.

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communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the thergill prize of £25 and a silver medal for paper on "The Best Means of Effectually venting the Leakage of Current to Earth in ctrical Installations from Generating Heat d Setting Buildings on Fire." The paper uld consist of about eight thousand words, d be written with a view to being read d discussed at an ordinary meeting of the ciety.

Papers submitted for the prize must be sent the Secretary on or before 1st of October, 96. Each paper must be typewritten, and ar a motto, the name of the writer being closed in a sealed envelope with a similar tto. The judges will be appointed by the uncil.

The Council reserve the right of withholding prize or of awarding a smaller prize or aller prizes, if in the opinion of the judges essay deserving the full award is sent in.

IZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are pared to award, under the terms of the njamin Shaw Trust, a Gold Medal, or a ze of £20.

The medal, under the conditions laid down the testator, is to be given "For any discovery, invention, or newly-devised method for viating or materially diminishing any risk to , limb, or health, incidental to any indusal occupation, and not previously capable of ng so obviated or diminished by any known d practically available means."

ntending competitors shall send in descripns of their inventions not later than the t December, 1896, to the Secretary of the ciety of Arts, Adelphi, London, W.C.

The Judges will be appointed by the uncil.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

CANTOR LECTURES.

ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. Fleming, F.R.S.

Lecture III.—Delivered February 19, 1896.

The Testing of Transformers.

Having considered the action and construction of transformers, our next duty is to notice the principal facts connected with the testing of transformers. This is a matter of considerable importance. It is not too much to say that in very few alternating current stations is there any proper system of purchasing transformers to a rigid specification, and enforcing delivery to this specification by efficient methods of electrical testing. Engineers appear to be far too often quite content to accept manufacturers' figures without any confirmation. As an instance of the possible consequences of such a course I may mention that not long ago I had occasion to specify for two transformers on behalf of a Corporation, the core loss of these transformers was to be not greater than 550 watts when measured at the proper primary pressure, and on open secondary circuit. When the transformers were delivered they were tested. One of them was found to comply with the specification, the other took up 1,090 watts under the same circumstances. As these transformers were 30 kilowatt transformers, intended to be worked in a substation, and to be connected with the mains for at least 4,000 hours in the year, it is perfectly clear that if no test had been applied, and if the transformers had both been accepted, one of these transformers would have taken up 500 watts more than the other. This additional core loss, proceeding for 4,000 hours in the year, would have meant an addition to the magnetising losses of 2,000 Board of Trade units per annum. As this would have involved an expenditure in coal and water of at least one penny per unit, the facts, translated into money, mean that one transformer would have cost something like £8 per annum more than the other to maintain magnetised. If this is capitalised at only 3 per cent. it means £240, whereas the actual cost of the transformers did not exceed £140 each. It is clear, therefore, that the omission of a systematic process of testing transformers and of specifying for them for test may involve a Supply Company or Corporation in an increased annual expenditure for maintenance, which under some circumstances may even amount to a considerable sum. In dealing briefly with the subject of testing transformers I shall not attempt to describe all the many different methods which have been suggested, but confine myself shortly to one which is simple, direct, and can be applied in any sub-station or workshop. It should always be remembered that although an electrical method may theoretically give the required result, yet practically it may be difficult to get good results with it on account of the fact that to obtain the necessary accuracy we must assume an unattainable precision in some of the measurements. The method which, after long experience in this matter, I have found most applicable in all ordinary cases is one depending on the employment of a properly constructed wattmeter, standard power absorbing resistance, and an auxiliary transformer. We will discuss, in the first place, the construction of each of these instruments separately. If an alternating current is sent through a fixed coil of wire, and another current through a movable coil suspended with its magnetic axis at right angles to the first coil, the centres of the coils being co-incident, then in general we find an electrodynamic force tending to turn the movable coil from one position to another. If the initial position of the coils is with their magnetic axes at right angles, then the passage of the current tends to displace the magnetic axes so as to make them co-incident. If a couple or torque is applied to the movable coil to bring it back to its original position, either by means of a spiral spring or a torsion wire, it can be shown that the couple required to hold the coils in their initial position, with magnetic axes at right angles to one another, is proportional to the mean value of the product of the instantaneous values of the two periodic currents passing through the two coils taken at equi-distant intervals throughout one complete period. This mean product is, therefore, at once measured in terms of a mechanical couple. Such an arrangement is called an electro-dynamometer. If the current through one of these coils is the current being supplied to an inductive circuit, say a transformer, a if the current through the other circuit, s the movable circuit, can be made to be p portional to the potential difference betwe the extremities of the inductive circuit, th the dynamometer, now called a wattmet will give us when used as above described, t true mean value of the product of the insta taneous values of the current through the i ductive circuit, and its terminal potent difference taken at equi-distant interva throughout the phase; this mean product is measure of the mean power being taken up that instant in the inductive circuit, and hen we are able by one measurement to measu this power. In order that good results may obtained with a wattmeter constructed as abo described when employing alternating curren there are certain precautions which must observed, but which instrument makers almo habitually disregard. In the first place th wattmeter must be constructed entirely of no conducting material. There must be no meta either iron or brass, in or near the fixed movable coils. The reason for this is that metal is placed in this position the alternatin currents circulating in the fixed or movab coils set up eddy currents in this metal, an these eddy currents re-act upon the movab coil, and cause a displacement which creates false reading. In the next place, in order make the instrument direct reading it essential that the fixed coil should be con structed in two parts, which are capable being moved to or from one another, so a to strengthen or weaken the field in th place where the movable coil hangs. In thi manner the wattmeter can be adjusted, s that a certain angular deflection of th torsion head of the instrument, creating certain definite couple acting on the movabl coil, can be made to mean a certain de finite amount of mean power passing throug the instrument. Thirdly, precautions must b taken to prevent the effect of the currents i the wires bringing the currents to or from th wattmeter affecting the movable coil. For thi purpose these leads ought to be constructed c concentric cable, and the wattmeter carefull tested, before employment, to find out if thi cause of error exists. In the next place w require a non-inductive resistance to act as a standard power-absorber. This can best b made by employing the cages as described i the first lecture. A series of these inductionles resistances, say 20 of them, each capable o withstanding a pressure of 100 volts, are joined

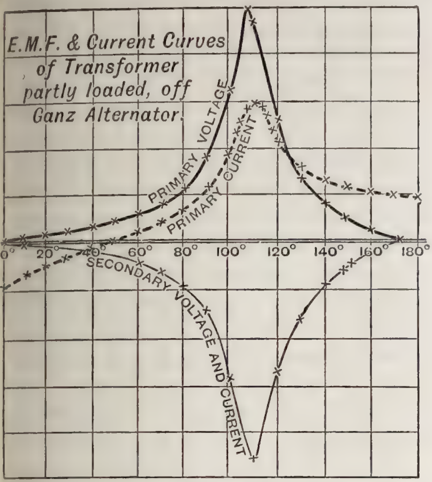

FIG. 34.

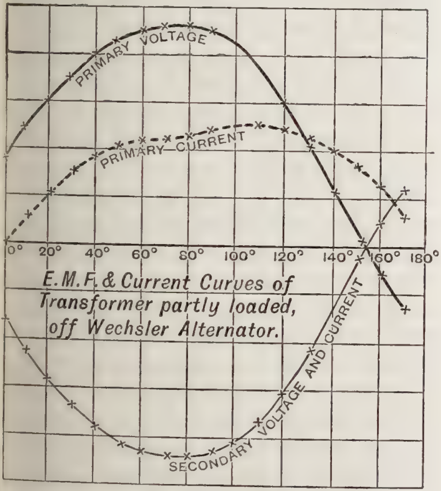

FIG. 35.

p in series, and well insulated. Under these ircumstances, a pressure of 2,000 volts can be laced on the extremities of this resistance, nd a certain current will flow through it. This urrent can be measured by a sensitive dynaıometer, which has previously been calibrated ı the usual way. The potential difference etween the extremities of the non-inductive esistance when employed on a high-tension ircuit is best measured by means of an electrotatic voltmeter. Then lastly, we require n auxiliary transformer for the following urpose. It has been explained in Lecture I. ıat when a transformer of the closed iron rcuit type is worked on a constant potential rimary circuit, the secondary electromotive rce set up in the secondary circuit is exactly opposite in phase to the primary electromotive force. This is further illustrated by the curves in Figs. 34, 35, 36, and 37, which show the primary and secondary E.M.F. curves of a Ganz, a Wechsler, and a Westinghouse transformer in various conditions of load, and it will be seen that the primary and secondary E.M.F. curves are in step with one another but opposite in phase. If, therefore, a transformer has its secondary circuit closed through a non-inductive resistance the secondary current will always be exactly opposite in phase, but proportional in magnitude to the potential difference between the primary terminals of the transformer. In order, then, to make a measurement of the efficiency of any transformer, this apparatus is arranged as in Fig. 38, the transformer to be tested is denoted by the lines over the words "Transformer under test." The wattmeter has its fixed coils connected in series with the primary circuit of the transformer to be tested, and its movable coil is connected in series with the secondary

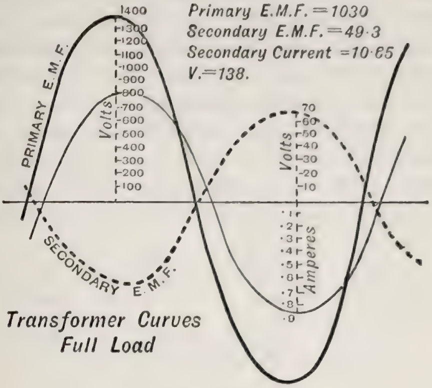

FIG. 36.

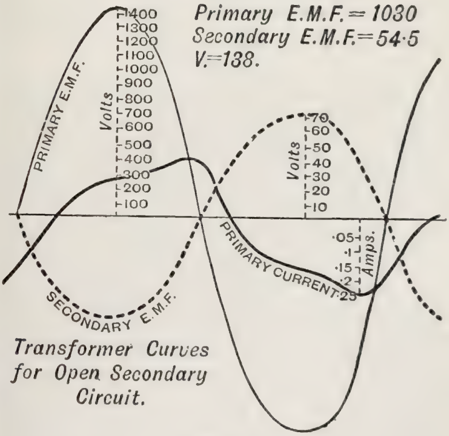

FIG. 37.

circuit of the transformer, which is called the auxiliary or *wattmeter transformer*, and by including a few incandescent lamps, L, in the secondary circuit of this auxiliary transformer, the proper current can be given to the movable coil of the wattmeter. The primary circuit of the auxiliary transformer is connected to the same two mains as the primary circuit of the transformer to be tested, and an electrostatic voltmeter, V, is joined across the primary terminals of the transformer to be tested. The standard inductionless resistance just described is also placed across the primary terminals of the transformer to be tested, and a two-way high tension switch is arranged so as to throw on the resistance or the primary circuit of the transformer under test at pleasure. A dynamometer is connected in series with this standard resistance to measure the current passing through it. The process of measuring the power supplied to the transformer under test is then as follows :—In the first place, we connect to the wattmeter the standard power of absorbing resistance, and observe the current flowing through it, and the potential difference between its extremities. The product of these two numbers in amperes and volts gives us the mean power in watts taken up in the standard resistance. At the same instant a reading of the wattmeter is taken ; that is to say, an observation of the amount of torsion required to be given to the wire or spring holding the movable coil to bring it back into its normal position. Let this reading be D_1, and let the power tken up in the standard resistance in watts be represented by W_1. In the n
place, the standard resistance is switcl
off, and the transformer under test
switched on to the wattmeter, and anotl
reading is taken of the wattmeter. Let t
reading be D_2. The true power being tak
up in this transformer under test is given
the value of the expression $\frac{D_2}{D_1}\times W_1$. In t
manner the wattmeter is employed as a ki
of electrical steelyard, to weigh or measu
the ratio between the known power taken
in the standard resistance and the unknov
power taken up in the transformer. A measui
ment can thus be made with extreme accurac
either in a central station, a transformer su
station, or a private house. All that it
necessary to do is to connect the wattmet
in the manner described, in place of one of t
primary fuses ; that is, to place the seri
coil of the wattmeter in series with the tran
former under test, and then to connect up t
standard resistance and the auxiliary tran
former, as shown in the diagram. The irc
core loss of a transformer on open seconda
circuit can thus be quickly and accurate
measured, and, with a properly construct
wattmeter of the kind described, there is n
the slightest difficulty in making the measur
ment of the core loss of any required degree
accuracy.

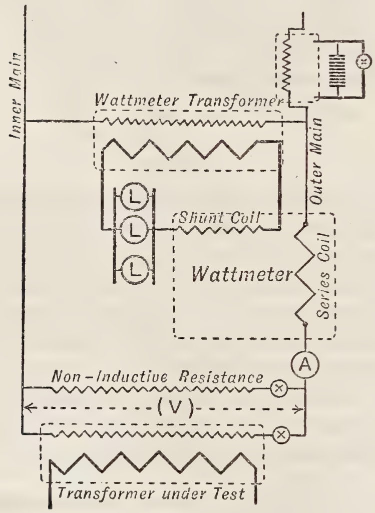

FIG. 38.

The wattmeter before you, and the standa
resistances have in this way been used for a
extensive series of measurements on the efl
ciency and core losses of the transformers
the City of London Electric Lighting Con
pany. No difficulty was found in makin
these measurements, even in the small unde
ground sub-stations which are distribute
about the City. In addition to the iron coı
loss of the transformer on open secondar
circuit it is also necessary to make two oth
measurements ; one of these is the copp
resistance of the two circuits of the trans
former when the transformer is warm. Th
most easy method of doing this is by mean
of the fall of potential method. When th
resistance of the primary circuit is moderatel
high, say anything over 5 ohms, it can be ver
easily measured on the ordinary Post-offic
Wheatstone bridge, taking the precaution
however, to short circuit the secondary circuit
but in those cases in which the resistance c
either or both circuits is very low then it is bes
measured in the following manner. A suitabl
standard low resistance, either $\frac{1}{100}$th or $\frac{1}{10}$tl
of an ohm, or 1 ohm is connected in serie

h the transformer circuit to be measured, d a small current from a dry cell or ondary battery is sent through this cir- t, appropriate resistance being added to rease the total resistance to a proper iount. A movable coil high-resistance lvanometer has its terminals then connected st to the extremities of the standard low sistance, and second to the terminals of the pper circuit of the transformer which is der test. The ratio of these two deflections /es us at once the ratio of the resistance of transformer circuit to that of the standard v resistance, and in this manner the copper sistance of each circuit of the transformer n be measured. This copper resistance, wever, if measured at the ordinary tempera- e of the air has to be corrected to determine iat it is when the transformer has reached constant temperature. When a trans- mer is put to work, whether on open cuit, or closed secondary circuit, it soon aches a final temperature, which ought ver, under any circumstances, to be more an 100° Centigrade. In order to determine iat this temperature is, one of the easiest thods is to connect the transformer on open condary circuit for 5 or 6 hours to the high- essure circuits, and when the transformer s reached its final and constant tempera- re to suddenly switch it off, and quickly make measurement of the copper resistance of e secondary circuit as above described. ien, when the transformer is quite cold, other measurement of the copper resistance ay be taken, which will be found to be much ss, since the high-conductivity copper em- oyed in transformer manufacture has a tem- rature coefficient of about 0·4 per cent. per gree Centigrade, it is very easy to calculate m these two measurements what is the final d constant temperature of the transformer. aving then measured the copper resistances, d calculated what it will be at the final tem- rature of the transformer, we have next to easure the secondary drop between full and load. For this purpose an electrostatic ltmeter is connected across the secondary cir- its, and its reading taken when the primary rminal potential difference is also known. ie transformer is then loaded up to its full ad on its secondary side, and the primary tential difference being kept at the same iount, the secondary potential difference will found to have fallen, and the amount of fference between its value when the trans- mer is fully loaded and its value when the transformer is on open circuit is called the secondary drop. It is sometimes difficult to make this measurement with great accuracy, especially when the transformers are working off commercial circuits, but it can always be done in the way shown in the diagram in Fig. 39, if we possess two identical transformers, and a low reading electrostatic voltmeter. The two transformers are connected up with their primary circuits in parallel, and with their secondary circuits opposed to one another through the voltmeter. The voltmeter then reads, not secondary volts to either transformer, but the difference between the two differences. If one transformer is loaded up to full load, the voltmeter will read directly the secondary drop, and since both transformers are affected equally by any variation of the primary pressure, it does not affect their difference, and, therefore, there is no difficulty in getting the measurement with any required degree of accuracy. Having in this manner measured the iron core loss at no load, or on open secondary circuit, the copper resistances when the transformer is warm, and the secondary drop, we have all the information necessary to enable us to make a complete report on the transformer. It has been abundantly shown by experiments which were carried out by me in the year 1892,* that when a transformer is gradually loaded up, the iron core loss is constant at all loads, and that it is only the copper losses that vary. Hence, if we know the iron core loss—that is to say, the loss due to eddy currents and hysteresis in the core when the transformer is on open secondary circuit, we have only to add to this loss the

Diagram of Connections for measuring the Drop in Volts of a Transformer.

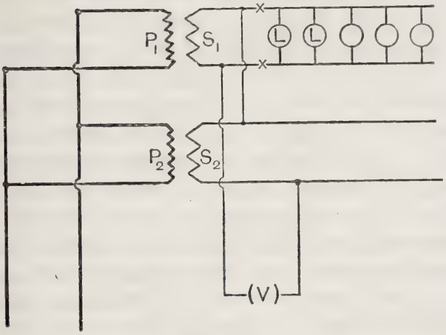

Fig. 39.

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* See "Experimental Researches on Alternate Current Transformers," by J. A. Fleming. "Proceedings of the Institution of Electrical Engineers," November, 1892.

copper losses in the transformer, that is, the energy losses due to the resistance of the copper circuits, in order to obtain the total power absorption in the transformer at any load. Let P_1 be the total power in watts given in a transformer on the primary circuit, and let P_2 be the total power in watts given out on the secondary circuit to some external resistances, such as lamps. Let I be the total iron losses in the transformer, and C the total copper losses, $P_1 = I + C + P_2$. Hence the difference between P_1 and P_2 is a quantity which can be calculated when we know I and know C; and the efficiency of the transformer is given by the ratio of P_2 to P_1, expressed as a percentage. The copper losses can be calculated with sufficient accuracy in the following manner:—Let us suppose that the transformer under test is a 10 kilowatt transformer, that is to say, is constructed to permit 10,000 watts being taken out from the secondary circuit, and that the secondary watts are intended to be 100. Then the transformer at full load will give out a current of 100 amperes. If we imagine the full load of the transformer to be divided into 10 parts, then when the secondary circuit is delivering 10 amperes at 100 volts the transformer is on 1-10th load, when it is delivering 20 amperes at 100 volts the transformer is on 2-10th of full load, and so on. If the transformation ratio of the transformer is known, that is the ratio between the secondary volts and the primary volts, or secondary terminal potential difference and primary terminal potential difference, when the transformer is on open secondary circuit, then the primary current can always be calculated with approximate accuracy from the secondary current by simply multiplying the secondary current by the number expressing the transformation ratio. Hence we can calculate the primary and secondary currents corresponding to each decimal fraction of full secondary load. Knowing the resistances of the two circuits of the transformer when warm we can, therefore, calculate the copper losses in each circuit, because if R is the resistance of a circuit, and C the R.M.S. value of the current flowing through it, then C^2R is equal to the mean power wasted in that circuit. Calculating in this way the total copper losses for the two circuits corresponding to each decimal fraction of the full secondary load, we can add these values to the constant iron core loss experimentally determined, and obtain the total power lost in the transformer, corresponding to each decimal fraction of full load. We have, therefore the difference b tween P_1 and P_2, corresponding to kno values of P_2. Hence we can calculate t ratio of P_1 to P_2 for each decimal fraction the full secondary load, and, therefore, have the efficiency of the transformer, and t total loss in the transformer given to us each fraction of the full secondary load. Th is by far the best method of determining t efficiency of very large transformers, becau it does not necessitate loading up the trar former to its full load on an actual resistanc and even if this can be done, the measu ment which we actually require is the diffe ence between two large observed quantiti and is, therefore, very liable to be affected an error in either of them. Having obtain in this manner the total losses in the trar former for the various decimal fractio of the full secondary load, the most co venient graphic method of representing t results is by a total loss diagram. A ho zontal line is taken, and is divided into 10 equ parts representing the decimal fractions of t full secondary load. At each part a vertic line is set up, representing the total losses the transformer, both the copper and the ir losses, and two curves are drawn, as in Fi 40, one representing the variation of the tot copper losses in the transformer with th secondary load, and the other representing th constant iron loss at all loads. From this curv another curve, called the efficiency curve, ca be drawn in the following manner (see Fig. 41 A horizontal line is taken, representing th secondary output, and divided into 10 equa parts representing the decimal fractions of th full secondary load. At each point a vertica line is set up, representing the ratio betwee the power given out by the transformer to th

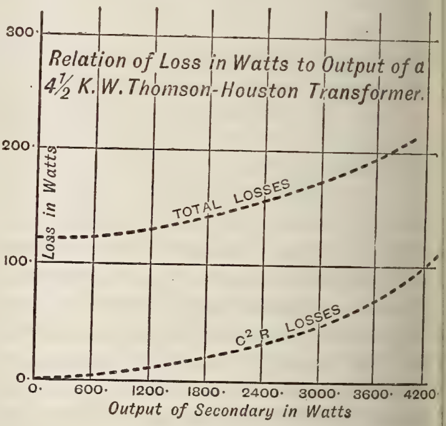


FIG. 40.

wer taken in by the transformer, expressed a per-centage, and the curve delineated by ese points gives us the efficiency curve of the ansformer. In a well-designed transformer is efficiency curve is a square shouldered rve, rising very rapidly up to 90 per cent. at e-tenth of full load, and to 96 or 97 r cent. at full load. A fairly good timate of the value of a transformer, om an efficiency point of view, can be tained by taking its efficiency at one-tenth full secondary load. Even quite small ansformers are now made which have an ficiency of 80 per cent. at one-tenth of full ad. Large transformers of 30 to 50 kilowatts d upwards can be made to have an effici- cy of 90 per cent. at one-tenth of full load. en years ago it was difficult to get any ansformer having more than 40 to 50 per nt. of efficiency at one-tenth of full load.

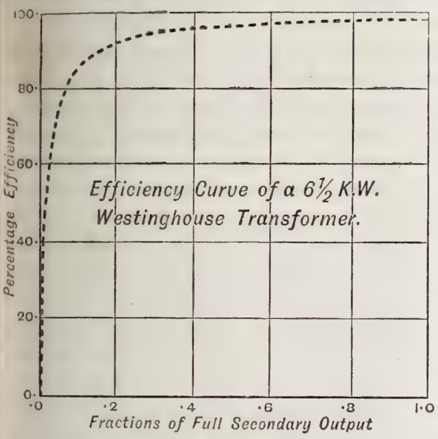


FIG. 41.

It should be noted, however, that the form f this efficiency curve, as well as that of the urrent curve, depends upon the nature of the urve of primary E.M.F. The diagram in ig. 30, Lecture II., shows the difference hich may exist in the efficiency curves in e case of the same transformer tested in o different alternators, a Ganz and a Vechsler.

In considering the performance of trans- rmers, we are not only concerned with the stantaneous efficiency—that is, the efficiency nder any particular load—but with what is alled the all-day or all-year efficiency. This an be calculated when we know the efficiency f the transformer at various loads, and when e know the nature of the load diagram, as it called, on which the transformer is supplied. hus, for instance, let us make the assumption that the load diagram of a transformer is a 10 per cent. load diagram—that is to say, let us assume that out of the 24 hours, for 11 hours the transformer is giving no current from the secondary circuit, for 5 hours is supplying at one-tenth of its full secondary output, for 4 hours one-eighth, for 3 hours one-quarter, and for 1 hour three-quarters. It will be found, on adding up these outputs, that they amount to one-tenth of that which the transformer would be supplying, if working at its full secondary output for the whole 24 hours. Let us take, then, the case of a 24-hour kilowatt transformer, having 1·35 per cent. loss on open secondary circuit, and 1·35 per cent. — 1·60 per cent. loss at full load. This gives an open circuit loss of 324 watts at no load; that is to say, 324 watts is the bore loss in the transformer at no secondary load; the efficiency at 1-10th full load is 86 per cent., and at full load 96 per cent. From the total loss diagram it can then be shown that the transformer takes up in its primary circuit 324 watts on open secondary, 2,762 watts at one-tenth of full load, 3,372 watts at one-eighth of full load, 6,420 watts at one-fourth full load, and 18,162 at three-fourths of full load. We can then construct an energy balance-sheet for the transformer as follows, putting on one side the energy in watt hours given by the primary circuit, and on the other side the energy in watt hours taken from the secondary circuit, and these figures will be as follows:—

Energy in watt-hours given to primary circuit.

11 × 324 = 3,564
5 × 2,762 = 13,810
4 × 3,372 = 13,488
3 × 6,420 = 19,260
1 × 18,612 = 18,612
Total = 68·734 Board of Trade units.

Energy in watt-hours taken from secondary circuit.

11 × 0 = 0
5 × 2,400 = 12,000
4 × 3,000 = 12,000
3 × 6,000 = 18,000
1 × 18,000 = 18,000
Total = 60·000 Board of Trade units.

It will be seen, therefore, that the total Board of Trade units given in the primary circuit in the 24 hours are 68·734, and the total Board of Trade units taken from the secondary circuit in 24 hours are 60·000. The secondary output is, therefore, 87 per cent. of the primary intake, and this is called the all-day efficiency of the transformer on that old diagram. It is not very far from the instantaneous or actual efficiency of the transformer at one-tenth of full load. It will generally be found that the actual efficiency at one-tenth of full load is a very fair guide to the all-day efficiency on a load having a load factor of 10 per cent. One thing that should be noticed in connection with this part of the subject is that the iron core losses in the transformer are diminished as the transformer heats up. The curve in Fig. 42 shows the results of an experiment with a 50 kilowatt transformer. The transformer was taken up when perfectly cold, and its core loss was measured and found to be 983 watts. This transformer was then connected with the circuits, and the core loss was taken at various intervals during a period of 20 hours until the transformer had reached a final constant temperature. It was then found that the iron core loss had fallen to 893 watts. The transformer was then disconnected from the circuit and allowed to cool, observations being taken during that period. After 24 hours the transformer had again become quite cold, and the core loss had risen up to 983 watts. There is, therefore, a difference of 100 watts, or nearly 10 per cent. in the core loss of the transformer when taken hot and when taken cold. This experiment shows the necessity for defining the conditions under which the core loss and efficiency of a transformer shall be taken; it is not enough to specify simply that the efficiency shall be of a certain value. It must be specified under what conditions this efficiency is to be taken, whether with the transformer cold or the transformer warm. In addition to this, there is a variation of the iron core loss taking place with time.

Variation of Core Loss of a 50·K.W. Transformer with Temperature.

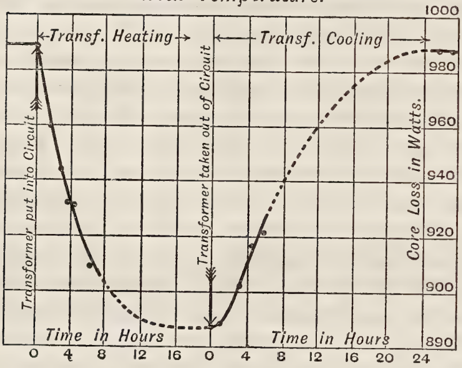


FIG. 42.

When a new transformer, which has nev before been used, is connected with the ci cuits, it is often found that when core lo measurements are made continuously at regul intervals, the core loss goes on increasing, a this may take place to the extent of 40, 50, even 100 or more per cent. increase. In fa instances have been noticed in which a co loss has increased in the course of a fe months to three times its original value. M Mordey found that he could produce th effect in iron by slow heating. It does n occur in all transformers. In an experiment specially tried with two new Thomson-Houst 30-kilowatt transformers, which were connect to the circuits night and day for three month and regularly measured at intervals, no app rent increase in the core loss was found. T reasons for this permanent increase in t hysteresis loss are not yet entirely explaine In the case of some iron which has been ve carefully annealed, it is found there is remarkable rise in the hysteresis loss when iron was used as the core of a transforme The same rise is also found in the case of ir which has not been very carefully anneale We cannot at the present moment state pr cisely what are the conditions under which th increase in core loss takes place, or what the constituent in the iron that tends to pr duce it. It has been supposed by some invest gators that the presence of silicon in the ir has a tendency to determine this increase the hysteresis loss, as the iron is magnetical used. It, however, points to the necessit not only of testing transformers at first, whe they are purchased, and before accepting, b of taking a series of tests of the transfomer regular intervals. Suppose that in a su station there are three or four large tran formers, and that one of these transformers made the master transformer, and is kept co nected with the circuits night and day, t others only being switched on during the ti of heavy demand; then it is obviously a ve important matter that the transformer, whic is thus made the master transformer, should the one which has the least core loss; and if should happen that this transformer is one whic has largely increased its core loss by use, the it should be exchanged for another which h the least obtainable core loss for that size transformer. In every sub-station the wat meter arrangement described at the beginnin of this lecture should be capable of being s up in order to make core-loss measuremen in a systematic manner. It is perfectly cle at if a few thousand Board of Trade units ore than necessary are being wasted in each nsformer sub-station, that the total value of se Board of Trade units when added up d capitalised may realise a very considerable m of money.

For the purpose of testing large transformers workshops without requiring a large con- mption of power, Dr. Sumpner has devised lifferential method of testing, the arrange- nts of which are shown in the diagram in g. 43. In this case the power given out by

Sumpner's Differential Method of Testing Transformers.

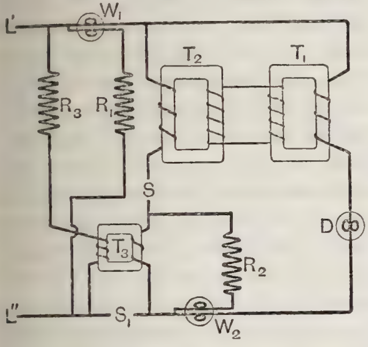


FIG. 43.

e transformer on the secondary side is put ck into the primary circuit by means of other reverse transformer, so that what is tually taken from the primary mains is erely the total loss in the two transformers. is total loss is measured by a wattmeter rangement, which enables us to measure, erefore, the efficiency of the two trans- mers taken together, and, therefore, if they e identical, the efficiency of either of them.

addition to the efficiency tests, there ought ways to be a series of security tests to test e strength of the transformer. In the first ice, the temperature should be taken after e transformer has been connected to the ains for 24 hours on open circuit, and then nnected to the mains for two hours on full condary load. This temperature is best ken, as described in the beginning of the cture, by measuring the resistance of the pper circuits, but it may be checked by ans of a thermometer placed inside the se. Under no circumstances should the nperature in the interior of the transformer e above 100° Centigrade. In the next place, ctric pressure equal to double the primary ssure ought to be put on between the mary and the secondary circuits for at least 15 minutes, and the same double pressure ought to be put on between the primary and case—that is to say, if the transformer works at 2,000 volts on the primary circuit, 4,000 volts should be put on between the primary and secondary circuit for 15 minutes, and 4,000 volts between the primary and case for 15 minutes. In addition to this, the transformer should be tested for several hours at the normal pressure before being put to work. In the case of large transformers which have stood idle for some time, it is not wise to put on the full primary pressure at once. The transformer should be gradually warmed up by passing a large current through the secondary circuit of the transformer, the primary circuit being short-circuited. In that manner the transformer will be gradually heated up, any moisture which has been absorbed into the insulating material or into the case will be got rid of, and the transformer will be gradually brought into a condition of high insulation. Transformers which have been standing in the stores for a long time may frequently fail if put suddenly on to the working circuits without some such precaution.

Next, with regard to magnetic leakage, it is important to employ some test to ascertain whether there is a large magnetic leakage. Magnetic leakage, as already explained, is due to an escape of induction, linked with the primary circuit, and which does not entirely pass through the secondary. It is promoted by any separation of the primary and secondary coils, as in Fig. 44, but is not entirely eliminated by any arrangement of them, as may be seen by considering the diagrams in Fig 45. This leakage, of course, can be ascertained by measuring the secondary drop as described above, and comparing that value with the total copper drop as calculated by the rule already given. An experimental proof of magnetic leakage can be obtained by a simple method due to Mr.

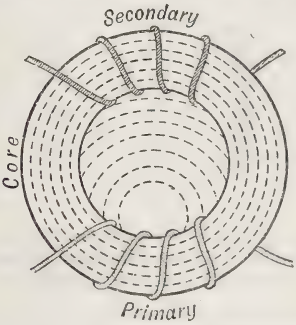


FIG. 44.

Mordey. Two thermometers are taken, one filled with mercury, and the other filled with alcohol. These thermometers are compared to see that they are in agreement at the ordinary temperature. The bulbs of the thermometers are then introduced into any portion of the transformer near the secondary coils and kept there for some time. If there is any leakage of magnetic induction outside the secondary circuit, this induction passing through the mercury thermometer will generate heat in the mercury and cause the mercury thermometer to rise, but the spirit thermometer will be unaffected by this process. Hence, although both thermometers will rise from external temperature, if the mercury thermometer rises more than the spirit thermometer it indicates the presence of magnetic leakage at that spot where the bulbs are placed. In some transformers magnetic leakage is actually encouraged. A transformer, designed by Elihu Thomson, intended to give constant currents from the secondary circuit when the primary circuit is worked off a constant potential circuit, is constructed as shown in Fig. 46. In this case, there is a kind of iron bridge, interrupted by an air gap across the core between the primary and secondary circuit; and across this bridge, or air gap, induction is forced as the secondary current increases. This leakage, therefore, diminishes the electromotive force in the secondary circuit, and that effect tends keep down the secondary current, and hen to preserve it at a constant value. Suc transformer can, therefore, be employed work arc lamps in series off a constant pot tial primary circuit. The secondary drop found to be affected to some degree by nature of the alternators on which the test v made. A peaked primary E.M.F. curve gi a greater leakage drop than one with a m rounded form. In general, however, ma netic leakage is a thing to be discourag and every specification for transformers oug to contain a clause defining and limiting t amount of secondary drop. One conveni way of doing this is as follows :—Suppose t standard secondary electromotive force to 100 volts, and the primary electromotive for 2,000 volts, then the specification should defi that when the transformer is working on constant potential primary circuit of 2,0 volts, the secondary terminal potential diff ence on the transformer should be 100 volts half load. At full load the secondary potent difference should not be less than 98½ volts, a at no load should not be greater than 101½ vol In this manner the unavoidable seconda drop is, as it were, distributed half up and ha down, and is not so much felt on the lamps if the transformer gave its standard electr motive force at no load, and then experience the full effect of the drop when loaded up full load. Also in a specification for tran formers the manufacturer ought never to allowed to produce a high efficiency at the e pense of a large secondary drop, but such definition of the core loss and copper loss oug to be given that he is bound to produce an a round excellence. As a sort of guide to the ki of figures which may be obtained by good make in actual practice, the following Table may taken as representing the secondary drop an core loss in transformers of these vario sizes. These figures may be taken as a kin of indication of the core loss and seconda drop, which can be obtained in good mode practice in the construction of transformer Some makers may be prepared to do bette than this; but exceedingly small iron cor losses ought always to be looked upon with certain amount of suspicion, the importan question being, not how low can the iron losse be made, at first, but how long will they kee low when the transformer is being used; an this, as above stated, can only be determine by careful tests, made at intervals, as th transformer ages.

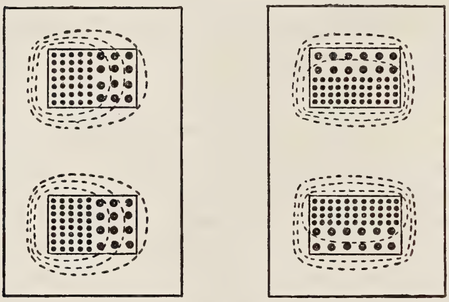
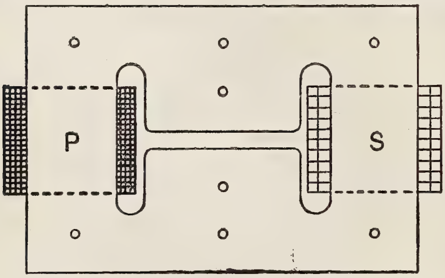


FIG. 45.



Thomson-Houston, Constant Potential to Constant Current, Transformer.

FIG. 46.

of transformer efined by full ondary output in watts.	Allowable iron core loss on open secondary circuit in watts.	Allowable secondary drop in per cent. of normal secondary electromotive force.
750	20 to 23	3
1,500	36 ,, 41	3
2,250	43 ,, 50	3
3,000	49 ,, 57	3
3,750	62 ,, 71	3
4,500	65 ,, 74	2¾
6,000	75 ,, 87	2
7,500	88 ,, 101	2
9,000	105 ,, 121	2
10,500	115 ,, 133	2
12,000	121 ,, 139	2
13,500	138 ,, 155	2
15,000	150 ,, 172	2

Miscellaneous.

INDIA-RUBBER AND BANANAS IN MEXICO.

ir Henry Dering, in his report on the produc- s of Mexico (already referred to) describes the ivation of India-rubber and bananas. The rubber is indigenous to Mexico and is found growing l along both coasts, below 22 degrees north lati- e, from sea level to altitudes running from 1,200 to o feet, and principally by the river meadows. ber is essentially a tropical tree, hence it requires ot and moist climate. The temperature best pted for its vigorous growth is above 86° Fahren- , and the rainfall should be at least 60 to 70 es per annum. There are eight kinds of rubber s that grow wild in the country, but the kind wn under the name of "Castilloa elastica" is the t important and the best, as it is very much ght for, for its sap and for propagation. Regard- the work of extracting the rubber one man will from 20 to 25 trees a day if the operation is per- ned carefully and methodically. In most places tapping is done in May and sometimes again in ober, but it is not advisable to repeat the opera- as often as that. The process generally consists aking two or three incisions in the lower part of tree and collecting the sap that flows from them on vessels placed next to the trunk. The process be repeated every year for 25 years or more cially if the wound is covered with wax or clay r the flow of the sap has ceased. When there is rge quantity of milk gathered it is placed in a el having a faucet and a solution of five ounces of ride or sub-carbonate of sodium in sufficient water over the whole mass, which is agitated with a stick every now and then. After the lapse of 24 to 36 hours the water is allowed to run out through the faucet, this operation of washing is carried on until the rubber becomes white. About 44 per cent. of rubber remains from the original amount of milk after the water and other matters have been eliminated by evaporation. Trees planted on lands having the soil, climate, and elevation adapted for the culture will produce from 5 to 6 lbs. of juice on the first year that they are tapped, which amount is equivalent to 2·4 lbs. of pure rubber. This product will be gradually increased every year for the next four or five years, and sell for 50 cents per lb. on the plantation. The total expense for a rubber plantation of 100,000 trees will not exceed 25,000 dollars, and as the yield of 100,000 trees will be about 240,000 lbs. at the first year's harvest, this will bring the planter 120,000 dollars, besides the product obtained from the side planting. The net profit on the investment, after deducting the entire cost of the land and all expenses up to the first year of harvesting, will be 95,000 dollars, and each of the succeeding harvests for 25 or 30 years will bring a steady income of over 100,000 dollars.

The Banana grows spontaneously and in very great abundance almost everywhere on the Mexican coast region and on the lower borders of the temperate zone. The plant is cultivated in all the States, excepting in the Distrito Federal, Baja California, Sonora, Coahuila, Chihuahua, Agréas Calientes, Mexico, Tlaxcala, and Campeche. Its cultivation is easy and cheap, and when properly carried out, the first crop may be gathered in ten or twelve months from the time of planting. As to the expenses, large plantations can be made at a cost of 3½ to 5 cents per plant, if planted 1,000 to the acre. The cost of clearing the ground is from six to eight dollars per acre; the price of 1,000 suckers or shoots from 20 to 25 dollars; staking, holing, and transplanting will cost 8 dollars 25 cents per 1,000 dollars; weeding and trimming, 6 dollars 25 cents per acre; and gathering the fruit, 6 dollars 25 cents per acre. At the end of the first year, 1,000 plants will yield 1,000 bunches, which sell at the plantation at 25 cents a piece, producing 250 dollars. The following year the yield is double that amount, and the expenses less than half.

IRRIGATION IN SIAM.

Siam has one enterprise of inland development which, in the opinion of the United States Consul at Bangkok, is well worthy of imitation—this is the experiment of constructing irrigation canals, which are also navigable for small craft. The most approved modern machinery is being used in this enterprise, and large tracts of land are being opened to settlement and improvement which before were jungle. Siam is essentially a land of waterways. Great rivers come down from the mountains in the north. On reaching the vast level plain that extends from the base of the foothills to the Gulf of Siam, they branch into lesser streams, which in turn are connected with numerous canals, some natural, and others artificial. The main artery of the kingdom, and the great highway of its inland trade, is the River Menam. From this most of the canals radiate, so that it is possible to proceed to almost any point in the country by boat. This accounts for the fact that there are no regular roads outside the capital (Bangkok), which is situated on the Menam, about 30 miles from its mouth. Notwithstanding that the land is cut with this system of rivers and canals, there are large sections with no waterways. It is one of these that the new enterprise is aimed to open. A company, called the Siam Canal and Irrigation Company, has been formed; and to this company the king has granted a concession. This concession includes a large extent of valuable but undeveloped land between the Menam and Bangpakong rivers, and not more than fifty miles from Bangkok. The grant was made on these principal conditions:—(1) The canals should be cut within the limits of the concession, in order that land might be sold to settlers; (2) the Government is to receive 20 per cent. of the net profits as royalty for granting the concession; (3) the land is to be sold on canals the width of which is 18 to 30 feet at 2 ticals (about 2s. 9d.) per rai (twenty forty-ninths of an acre); on those of 36 to 42 feet width at 4 ticals (5s. 6d.) per rai, and on those of 48 feet width at 5 ticals (7s.) per rai. In the course of construction are three canals, viz., one 48 feet wide and 9 feet deep, to be 32 miles long; one 36 feet wide and 7½ feet deep, to be 40 miles long; and one 30 feet wide and 4½ feet deep, the length of which is not exactly defined. Work further projected includes one canal 2½ miles long, with a width of 48 feet, and two others, respectively 36 and 30 feet wide, length not stated. The capital of the company is given as 320,000 ticals (about £22,000). It has purchased the latest patterns of excavators and dredges, and the former are kept working day and night. The progress of cutting the canals is very rapid owing to the lack of resistance in the material excavated. There are no stones whatever, and beneath the surface soil there is a deep stratum of clay which is cut as easily as cheese with a sharp knife. As the ground is not high, and is soaked for the greater portion of the year, the work is rendered still less difficult. In fact, this whole area would not need irrigation for northern crops, but for rice, the chief product of the land, there must be regular and continued flooding of the surface. The use of these canals is, moreover, not confined to irrigation; they provide the highways by which all the farmers carry their products to the markets. The canals are quite deep enough for the fleet of paddy boats that use them. Consul General Barrett says that if this project is completed successfully, there will be many others started. The digging of these canals may inaugurate a newer and greater prosperity for Siam; for it is, and must always be, essentially an agricultural country. No other country has land better ada to the growth of paddy or rice. Its export of staple during the last two years amounted in to over 42,000,000 silver dollars, and yet vast of rich land are still uncultivated.

General Notes.

Rio de Janeiro Exhibition.—Although National Exhibition which was held in the cit Rio de Janeiro in November last, and remained for nearly three months, was financially a failure results, according to Consul Wagstaff, were satisfactory, and caused surprise to many at the gress Brazil has made in several industries. R cottons are now all made in the country, and higher classes are beginning to compete with for goods. Silks are also produced, and great impr ment is noticeable in the quality. In woollens, national products, especially scarlet blankets, forcing out foreign goods, being well made dyed. Numerous distilleries and breweries are b established in Rio and its neighbourhood, and siderable business is being carried on. Unfortunat in Brazil adulteration of mineral waters, spirits, wi and liqueurs is largely practised. Nearly all for brands are manufactured, and European trade m infringed with impunity.

Mercantile Marine of Japan.—Under Tokugawa Government, private individuals not b permitted to own any ships of foreign type, tl was no scope for the improvement of a merca marine. It was in 1869, two years after the do fall of the feudal *régime*, that the prohibition first removed. At the end of 1870, the total num of ships of European model, both steam and sail was 46, with an aggregate registered tonnage 17,952 tons; at the end of 1893 these figures risen, says Consul Merritt, who quotes fron Japanese paper, to 1,429 and 155,172 respectiv Thus, during 23 years, the number of ships increa by 1,383, and the aggregate registered tonnage 137,220 tons; in other words, an average ye increase of 60 ships and 5,966 tons. As to ste ships, their number at the end of 1870 was 35, an aggregate registered tonnage of 15,498 tons, by the end of 1893 the number had increased to and 110,205 tons respectively. The number of ing vessels at the end of 1870 was 11, and th aggregate registered tonnage 2,454 tons, and th figures had become, in December, 1893, 749 44,960 respectively. In the latter half of the y 1894 the war with China led to a sudden and la increase in the number of Japanese vessels, especi steamers; so that by the end of that year Japan probably passed Turkey in the order of importa of ship-owning countries, and reached a tonna position close below Austria-Hungary. The Japan mercantile marine has, thus far, been principa occupied in the coasting trade.

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Notices.

?IZE FOR INDUSTRIAL HYGIENE.

Гhe Council of the Society of Arts are pared to award, under the terms of the njamin Shaw Trust, a Gold Medal, or a ze of £20.

Гhe medal, under the conditions laid down the testator, is to be given "For any disvery, invention, or newly-devised method for viating or materially diminishing any risk to , limb, or health, incidental to any indusil occupation, and not previously capable of ng so obviated or diminished by any known l practically available means."

ntending competitors shall send in descripns of their inventions not later than the t December, 1896, to the Secretary of the ciety of Arts, Adelphi, London, W.C.

Гhe Judges will be appointed by the uncil.

Гhe Council reserve the right of withholding prize or of awarding a smaller prize or aller prizes, if in the opinion of the Judges hing deserving the full award is sent in.

roceedings of the Society.

CANTOR LECTURES.

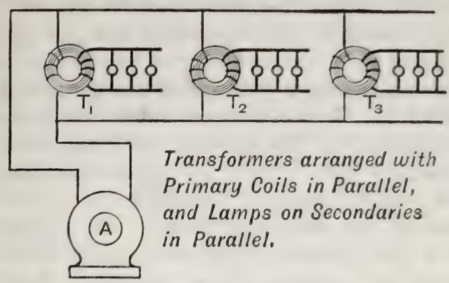
ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. Fleming, F.R.S.

ecture IV.—Delivered February 10, 1896.

HE EMPLOYMENT OF TRANSFORMERS.

n this last lecture I wish to direct your ention to certain problems in connection h the employment of transformers. I shall ume that the majority present are quite niliar with the ordinary methods of disuting electric current by means of transformers, whether by what is called the system of distribution by house transformers, as shown in Fig. 47, or the more modern and economical method by transformer substations. Generally speaking, the method of transformer distribution which is now found to be most practically useful in provincial towns and over large areas is somewhat as follows:—In the generating station, the alternators either send their current into one common set of omnibus bars, the alternators working in parallel, from which bars a distribution is made by high tension feeds to various transformer sub-stations, often a more complicated switch board is employed in which the high tension feeders coming from the various transformer substations can be connected at pleasure to any alternator, or grouped together in any way on one or more of the alternators. It would be foreign to our subject here, at the present moment, to enter at all into the question of the parallel working alternators. It has been fully discussed in the technical journals and other publications. The high tension feeders are generally arranged to convey a high tension current at a pressure of 2,000 volts to certain transformer sub-stations in which are placed a bank of transformers. These transformers take their primary current through primary switches and fuses from primary omnibus bars connected to the feeders, and the secondary circuits of the transformers are generally arranged to feed a three-wire system of low tension distribution. For this purpose each transformer is provided with three secondary terminals, and from the sub-station proceeds a three-wire low tension system which is fed by one or more of the transformers, and to which the consumers are connected. In joining up a bank of transformers in this manner it is important that each of the transformers should have an equal per-centage secondary drop for the same fraction of full load. Otherwise, if



Transformers arranged with Primary Coils in Parallel, and Lamps on Secondaries in Parallel.

Fig 47.

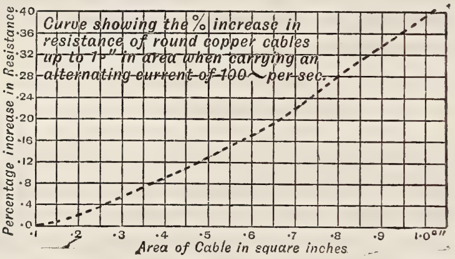
one transformer has a smaller secondary drop than another, that transformer with the least secondary drop will take the greatest share of the load as the sub-station is loaded up, and it may, therefore, get overloaded and get very hot, and such an inequality of load tends to increase, the more the bank of transformers is loaded up. It is always advisable to examine transformers in this manner, and if any transformer is found to have too large a secondary drop then to remedy it by adding one or more turns to the secondary circuit. In addition to a low tension distribution from transformer sub-stations it is sometimes found convenient to run one or more high-tension feeders to supply the outlying regions of the district which is then served with a system of house transformers. The plan which I have found convenient to adopt in developing an alternating current station in a provincial town in which there is a central shop district, in which the lighting is rather dense, and an outlying residential district in which it is rather scattered, is to arrange one or more low-pressure secondary networks on the three-wire system in the central portion of the town. Each of these networks is fed from a single transformer sub-station, and the secondary circuit forms a complete ring main, which is fed into by secondary feeders at three or four places. The transformer sub-stations are inter-connected by a high-pressure connecting main, which serves, in case of break down at one station, to allow the duty of that station to be taken up by another sub-station. It is not advisable, in my opinion, to connect together the different, separate, secondary networks. One great advantage of the alternating current system is that it enables us, by having small separate secondary distribution systems perfectly insulated from one another, to limit the effect of a dead earth on one of these secondary networks, and that is an advantage which cannot be obtained on the ordinary low pressure system where the distribution network is connected throughout.

As regards the description of cable to be employed, it is now well understood that concentric cable forms in all cases the most satisfactory of cable both for the high pressure and the low pressure conductors. By the employment of concentric cable, we eliminate at once any difficulties which would arise due to induction taking place on neighbouring telegraph and telephone wires; and we also largely reduce the inductive drop in pressure which would otherwise exist if the three members of the secondary circuit were separ cables separated by any distance from o another. My own experience is that t secondary network is best laid down by mea of triple concentric cable, and there are cert advantages in making the outer member this cable the middle wire of the three c ductor system. In any case, the house c nections are quite easily made. It is a desirable to get rid altogether of dist bution boxes and service boxes, whi become localities in which coal gas c collect and occasionally explode. In layi down the secondary distribution system means of lead covered and armoured trip concentric cable, by far the best plan is make the proper connection with a servi main to each house at the time that the cab is laid, and to have this joint entirely seal up in lead, making use of no junction-box all, or at most of a right-angle iron sleeve mechanically protect the joint. The servic main can then be taken into each shop house, and connected up to the consume terminals, whether the building takes light not. In the central portions of a town it only a question of time for every shop or hou to take the current, and it saves expense ult mately to make this joint in the first instanc The secondary cable having been laid in th manner should be tested, and my own pra tice is to insist upon a test of 1,000 volts b tween the different members of the seconda circuit when it is laid in the earth, but befo the house connections are made. If the cab stands this test it has a large factor of safet With regard to the high-pressure cable it customary to use ordinary duplex concentr cable, and if the service is a 2,000 volt servic then after the cable has been laid in the grou it should be tested by a pressure of 4,000 vol placed between the inner and outer membe for one hour, and a pressure of 2,000 vol between the outer member and the earth, a the cable should not be accepted unless it h passed this test. As it is always desirab to use concentric cables in connection with a modern transformer systems of distribution is necessary to pay attention to some peculi effects which are observed in connection wit concentric cables when supplying tran formers, and during the remainder of th lecture I propose to occupy your attenti chiefly with practical points connected wit these effects. They may be divided into fo classes. There are first those which may b called the resistance effects, which are effec nnected with the distribution of the current er the cross-section of the conductor employed r the transmission of the alternating current. condly, there are the capacity effects, which pend upon the fact that a concentric cable is large condenser or Leyden jar. Thirdly, ere are the resonance effects, which are e to the re-action of this capacity upon e alternators, or the primary transformers. ourthly, there are effects which may be called e initial stage effects depending upon the pacity of the cable, and the inductance the transformers supplied through it, th of which co-operate together to produce eculiar effects at the moment when the cable rrying the transformers is switched into nnection either with another live cable or ith an alternator. We shall consider each these in turn. It will be necessary to reface a detailed discussion of these effects y some general remarks upon the nature of rrent flow in inductive circuits. Every ectric circuit which has self-induction or ductance and capacity has a natural period of ectric vibration—that is to say, if the electric arge in it is disturbed, and then left to itself, oscillates backwards and forwards as water ould do in a long tube having the ends osed by elastic caps. In such a case, if e water was disturbed and then left to itself, would oscillate to and fro in virtue of the ct that the mass of water possesses inertia, nd that the elastic caps on the ends of the ipe permit the water to be displaced. In ther words, such a closed pipe has what ay be called hydraulic inertia and permit- nce. In the same manner, a circuit which as self-induction possesses what may be alled electric inertia or inductance, and a ondenser which permits of electric displace- ent to be made through its di-electric or on-conductor has what is called capacity r permittance. If a condenser with a apacity, C, is being charged through a re- istance, having a value represented by R, e product, C R, is called the time-constant f that system, and it represents the time in hich the charged condenser, if left to itself, ort-circuited by the resistance, R, would fall potential to a certain fraction (very nearly vo-thirds of its original potential); again, if is the inductance of a conductor, and R is s resistance, then $\frac{L}{R}$ is called the time-con- tant of that circuit, and this is the time in hich a current in that circuit would rise to bout two-thirds of its full value if a constant electromotive force is put upon the ends of the inductive resistance. The first product, C R, is called the electrostatic time-constant of the condenser and resistance, and the quotient, $\frac{L}{R}$ is called the electromagnetic time-constant of the inductive resistance. If, then, we join together in series a condenser having a capacity or permittance, C, and an inductive resistance having an inductance, L, and a resistance, R, it can be shown that the complete, free, periodic time of oscillation of a charge of electricity in that system is given by this expression:—

$$t = 2\pi \sqrt{\frac{L}{R}\,CR}.$$

In other words, the complete periodic time is equal to 2π times the geometric mean of the electrostatic and electromagnetic time-constants. It must be noted that this is the time of oscillation of the charge when left to itself, but it is of course perfectly possible to make what is called a forced oscillation, and that is what is done in every transformer system. These electrical quantities have their mechanical analogues. Suppose, for instance, we take a pliable lath with a weight on it, and fix it at one end, the pliability of the lath is the analogue of the capacity of the electrical system, the mass of the weight on the end is the mechanical analogue of the inductance of the system. If then we displace the lath or bend it and leave it to itself, it vibrates to and fro with a natural period of its own, in virtue of the fact that the system has pliability or permittance, and mass or inductance. If the mass be small and the pliability is small the time of vibration is small, but if the pliability is great and the mass is great then the time of vibration is great. Such a loaded flexible rod not only has a free period of vibration of its own if fixed at one end and set in oscillation, but we may give it a forced oscillation. Before explaining the manner in which certain electrical effects may be mechanically imitated by such a loaded lath, we will consider a little more in detail the properties of concentric cables when used with alternating currents. In the first place a cable intended for use with an alternating current must not have the metal or conductor of which it is made of a thickness exceeding a certain value, for the reason that a certain time has to elapse before the current is established in the central portions of the conductor, and, therefore, if the conductor is used with alternating currents, its actual resistance depends upon the frequency and the thickness of the conductor. Without going into more elaborate explanations on this point, for which I refer the reader to other text-books, I may give here a Table showing the resistance of high conductivity round copper conductors to continuous and alternating currents of a certain frequency, the results of which are set out graphically in a curve in Fig. 48.

FIG. 48.



The following Table shows us that practically the largest conductor which should be used in connection with alternating current work is a cable having an outside diameter equal to a 19/12 cable, and that if the cable has a greater diameter, then its resistance to alternating currents of a frequency 100 is sensibly different from its resistance to continuous currents. In the next place, with regard to capacity, suppose that a concentric cable is formed by putting one cylindrical tube in the interior of another cylindrical tube, the space between the tubes being occupied by a non-conducting material or di-electric having a specific inductive capacity equal to K, then if R_0 is the radius of the inside of the outside tube, and $R_,$ is equal to the radius of the outside of the inner tube, and if L is the length of the tubes, the capacity of this concentric cable in microfarads is given by this expression :—

$$C = \frac{K\,L \qquad\qquad\qquad I}{2\,(\log R_0 - \log R_,)\; 2{\cdot}303 \times 9 \times 10^5}$$

Then as regards the value of K for paper insulation, such as is used in the Ferranti cables, K has a value very nearly equal to 3; but if indiarubber is used, then K has a value very nearly equal to 4. On calculating out these values for most ordinary cables used for the conveyance of high tension alternating currents, it will be found that for such insulating materials as paper, Fowler-Waring composition, or various resinous substances, the capacity of the cable is generally about one-third of a microfarad per mile.

TABLE OF RESISTANCE OF HIGH CONDUCTIV
ROUND COPPER CONDUCTORS.

Cable. Strands and Size.	Total Cross-section Area in sq. inches.	Resistance in ohms per 100c	
		For Continuous Currents.	For Alte ing Curre Frequenc ∼ per sec
7/18	·0126	1·974	1·974
7/17	·0172	1·452	1·452
7/16	·0225	1·108	1·108
7/15	·0285	·878	·878
7/14	·0351	·712	·712
19/18	·0351	·712	·711
19/17	·0477	·524	·524
19/16	·0624	·401	·401
19/15	·0789	·318	·318
19/14	·0973	·257	·257
19/13	·1289	·194	·195
19/12	·1645	·153	·155
19/11	·2048	·122	·1247
19/10	·2500	·100	·1034
37/16	·1227	·204	·2041
37/15	·1551	·162	·164
37/14	·1913	·131	·1334
37/13	·2534	·099	·1024
37/–	·3000	·083	·087
37/12	·3235	·077	·081
37/11	·4000	·063	·068
37/10	·4905	·051	·057
61/15	·2582	·097	·1004
61/14	·3185	·078	·082
61/13	·4218	·060	·065
61/–	·5000	·050	·056
61/12	·5385	·046	·052
61/–	·6000	·041	·048
61/11	·6476	·039	·0465
61/–	·7000	·0357	·0435
61/10	·8167	·0305	·0391
91/13	·6354	·0385	·0458
91/–	·7500	·0330	·0412
91/12	·8111	·0305	·0391
91/–	·9000	·0277	·0370
91/11	1·0000	·0250	·0350

From what has been said above with regard
the resistance effect it must be noted that in t
construction of a concentric cable the maximu
thickness of the copper conductor cannot
more than about half inch. In cases whe
larger currents have to be conveyed than c
be carried through the equivalent of a 19/
cable it is desirable to employ two concent

ables in parallel. Let us consider then the apacity effects. If a long concentric cable is onnected to an alternator, the far end of the oncentric cable being insulated, it is found at an electric current flows into and out of e cable, which may be sufficient to light one r more incandescent lamps. This is called the apacity current of the cable, and it is a current owing across the di-electric or non-conductor om one copper member to the other. If C is e capacity of the cable measured in micro-rads, V, the difference of potential between e two copper members measured in volts, nd if p represents $2\pi\, n$, where n is the fre-uency, then the capacity current I is given by his expression :—

$$I = \frac{C,\ p,\ V}{10^6}\ .$$

hus, for example, supposing a cable, having capacity current one-third of a mile capacity, as a potential difference of 2,000 volts be-ween its inner and outer conductors, and p quals 500, then the capacity current is one-hird of an ampere, or equivalent to the light-g current of one 8 candle-power lamp. Ience, in very large concentric systems, this apacity current going out of the station may mount to a considerable value. We have en to consider briefly what are called the esonance effects. If an alternator is sepa-ately excited so as to give a certain poten-al difference at its terminals, suppose 2,000 olts, and if a long length of concentric cable connected to this alternator, the far end of e cable being insulated, then it will be found at such cable, when associated with the lternator, may greatly increase the electric ressure between the terminals of the alter-ator, and that for a certain critical length of e cable a very marked rise in pressure may ake place. The same will be found to be the ase if a long length of concentric cable is onnected to the high pressure side of a step-p performer being excited from a 100-volt lternating circuit on the low pressure side. ccordingly, in testing concentric cables, the ngineer must always be on his guard against is resonance effect. Suppose, for instance, is desired to test whether a certain length f concentric cable will stand 2,000 volts, the ost natural method of doing this would be to onnect the high pressure side of a step-up ansformer, raising the volts from 100 to ,000, and to serve the low pressure side of is transformer from a 100 volt circuit. The experienced person might naturally suppose that this would invariably place upon the cable a pressure of 2,000 volts, but under certain conditions, depending upon the capacity of the cable and the inductance of the transformer, the pressure might rise far beyond 2,000 volts between the two members of the cable, and the only method of making sure that this is not the case is to have an electrostatic voltmeter kept connected between the inner and outer members of the cable as the pressure is gradually increased.* Then, in the last place, not only are there the resonance effects above referred to, by which a concentric cable when switched on to an alternator or transformer permanently raises the pressure, unless the exciting current of the alternator is reduced, but there are certain very important initial effects which take place at the moment when a concentric cable is switched into connection with either an alternator or another live cable. If a condenser is connected with an inductive resistance, it can be shown that at the moment when this system is brought into connection with the source of alternating electromotive force, if the connection is made at a particular instant with respect to the phase of the electromotive force, there is an electrical oscillation set up in the combined condenser and inductive resistance, the amplitude of the oscillations of current greatly exceeding those which would exist when the steady state has been established, and oscillations of potential difference occur at the same time, the result of which is that the difference of potential between the two plates of the condenser will undergo a periodic change, the amplitude of the oscillations of which is, however, in the initial stage much greater than that of those which take place when the whole system has settled down into a steady condition under the influence of the impressed periodic electromotive force. Suppose, then, that a series of transformers are connected to the two copper members of a concentric cable, and that the concentric cable is, as usual, lead covered and steel armoured with a layer of insulation between the lead covering and the outer copper members. As already stated, there is a certain capacity in the concentric cable between the inner and the outer members, which will be generally something like one-third of a microfarad a mile, but, at the same

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* For a further discussion of these resonance effects, the reader is referred to "The Alternate Current Transformer" (Fleming), vol. ii. p. 383, *et seq.*, where a full discussion of these effects in connection with concentric cables is given.

time, there will be a capacity between the outer member of the concentric cable and the lead casing or the earth; and this capacity between outer and the earth, as it is called, is very much larger in general than the capacity between the inner and outer; it may be ten times as great. Hence, if the transformers are connected between the inner and outer conductors we may regard the primary circuits of the transformers, which are inductive circuits, as connected in series with a condenser, which is formed of the outer members of the cable and the lead covering. If, therefore, such a cable, with transformers attached to it, the secondary circuits of which are unloaded, is switched into connection with the omnibus bars of an alternating current station, the connection between the inner member of the cable with the proper omnibus bar being made first, then, at that instant, an electromotive force is impressed upon the system, consisting of the inductive primary circuits and the condenser in series with them. For a particular phase of the impressed electromotive force, it can be shown that oscillations of potential are set up in the condenser, causing a periodic potential difference between its two sides to be greater than that due to the steady action of the periodic electromotive force. This sometimes results in breaking down the insulation between the outer members of the concentric cable, and the lead covering, and as this insulation is generally in all cases made much thinner than that between the inner and outer members of the cable it is not unfrequently pierced. Alternating current station engineers are very familiar with failures of such concentric cables occurring between the outer members of the cable and the earth. The remedy for this is one of two things, first the *outer* member of the concentric cable must be connected to its proper omnibus bar *first* before the inner member of that concentric cable is connected. If this is done then it is impossible to set up destructive oscillations of pressure between the outer members of the cable and the lead covering. Another remedy is to introduce in the circuit with the inner member of the concentric cable a variable inductance which is gradually removed in such fashion that the inner member of the concentric cable is not connected suddenly with the source of potential, but is connected through a choking coil, the choking quality of which is gradually removed. This can be done in the following manner. A large transformer is arranged so that its secondary circuit can be gradually short-circuited by
lowering two lead or iron plates into an ins
lated tub of water; the primary circuit of t
transformer can be connected in series w
the inner member of the concentric ca
which is to be brought into connection w
the system. The operation then of connecti
the long concentric cable to the omnibus b
is as follows:—The series transformer first h
its secondary circuit opened, its primary c
is then connected in series with the inn
members of the concentric cable to be co
nected, and with the proper omnibus bar, t
outer member of the concentric cable is th
connected with the other omnibus bar, t
plates on the secondary circuit of the seri
transformer are then gradually lowered into t
water, and when the secondary circuit of th
series transformer is practically short circuit
the primary circuit of the transformer is al
short circuited, and the transformer is then r
moved, leaving the main in connection with t
omnibus bars. The operation, moreover, is pe
formed in such a manner that there is no ru
of current into the cable, and no possibility
setting up violent oscillations of potenti
between the outer members of the concentr
cable and the earth. In no case should lon
concentric bars be connected to omnib
bars or to other parts of an alternatin
current system without some such proce
as the above, of gradually setting up the fu
current in them, or else the risk of piercing th
outer insulation of the concentric cable is ve
considerable. Engineers, in connection wi
alternating current stations, should always b
on their guard against these initial effect
and remember that long concentric cable
with transformers connected to them, posses
a quality which resembles inertia, and tha
currents can no more be started and stoppe
instantly in these cables and transformers tha
heavy machinery can be started and stoppe
at once.

In addition to the initial effects taking plac
in cables, I showed, in 1892, that there we
certain initial effects, called current rushe
taking place in transformers when sudden
switched into connection with a live cabl
Under some circumstances, depending upo
the phase of the electromotive force in whic
the switch is closed, a strong rush
current may take place into the primar
circuit of a transformer, the maximum valu
of that current rising to twice the max
mum value of the current when the stead
state is established; and, under some con
ditions, in switching off a transformer, the

ay be a certain rise in the difference of
tential between the parts of the primary
rcuit and the iron case or secondary circuit
ich may pierce the insulation. If a large
rrent is flowing in an inductive circuit, and
switch is suddenly opened, interrupting that
rcuit at an instant when the current has
maximum value, then a large inductive
ectromotive force is set up in that circuit
ich may result in breaking down the
sulation between parts of that circuit.
e effect arises from the same cause
at frequently destroys the insulation of a
ld magnet of a continuous current motor or
namo if the field - magnet is suddenly
itched off at a moment when the magnet is
a state of excitation.* Broadly speaking,
a practical rule, it should be remembered
at long concentric cables having transformers
htly loaded connected to their ends should
ver be suddenly switched into connection
ith alternators, or switched off, but should
ways be put into connection with the source
electromotive force through a regulating
sistance or inductance, so arranged as to
event or check the formation of any oscilla-
ons of current other than those due to the
tural period of the impressed electromotive
rce. In the early days of the working of
any large alternate current stations many
fficulties were experienced owing to the
ilure of large transformers and the piercing
long concentric cables which were due to
ese causes, but experience has now shown
w to overcome these difficulties, and to
event any of these disastrous initial
fects. In many cases cables and trans-
rmers which suddenly fail when switched
to connection with the circuit after being
le for a time, have really been injured at
e instant when they were last switched out of
nnection with the working system owing to
e rise of potential that has taken place at the
stant when the current was interrupted at a
articular instant during its phase. Hence
e removal of a cable from a working system
the omnibus bar or at any intermediate
oint must always be effected with the same
are as the connection of a cable, and in no
ase should a long concentric cable, whether
nnected to transformers or not, be switched
n or switched off from the live omnibus bars
the station abruptly. This, of course, does
not apply so much to short lengths of a few hundred yards as to long lengths of one or more miles, but it behoves the engineer always to be on his guard against these sources of failure.

The time will not allow me now to develop at any greater length these points, and in closing this brief discussion on the construction and action of transformers, there is no need to emphasise the fact that much has perforce been omitted owing to the limits of our time, which a complete treatment would necessarily include. I have endeavoured to direct attention rather to a few principal practical considerations, and to portions of the subject not quite elementary in character, and to assume, as I said at the beginning, that the fundamental principles were already familiar to most present.

Great as has been the progress in ten years in alternate current working no one would be so rash to assume that we have reached the limit of its improvement. The practical perfection of the transformer placed in the hands of electrical engineers an instrument of enormous utility and power for effecting the distribution of electric current. Large as may be our indebtness to those whose scientific and constructive ingenuity has brought about this advance, but we must at the same time remember, with due mede of honour and praise, the pioneering experiments of Paul Jablockoff and Lucien Gaulard, in 1887 and 1882, which, even if not the first suggestions for the employment of the induction coil in electric lighting, certainly forced the attention of engineers to consider closely the value and use of that device, and the service it might be brought to render in the solution of the problems of public and private electric supply.

Miscellaneous.

FOREST WEALTH OF BRAZIL.

An interesting report on the forests of Brazil has recently been presented to his Government by the French Consul at San Paulo, who calls attention to the wealth of timber in them, more particularly in the forests situated in his own consular district. M. Georges Ritt says that among the sources of natural wealth in the province of San Paulo, one of the most interesting, but, unfortunately, somewhat neglected, is the timber of which the immense virgin forests are composed. The recent industrial exhibition at Rio de Janeiro, where a considerable number of samples of Brazilian wood were on view, was the means of calling attention to the value of these products and to the advantages to be derived from a regular and systematic working of the forests. The most important, as well as the most common, tree is the *pinho*, which is found in great abundance in the State of Parana also, and where it is known as the *araucaria*. In San Paulo the *pinho* has been sacrificed to coffee cultivation, and a large number of these trees have been destroyed, and the forests themselves burnt in order that the land might be prepared for the coffee plants. The *pinho* is, nevertheless, still found in great profusion in the western and southern parts of the province. The tree grows easily and rapidly, and attains a height of 45 metres. In twenty years it can supply large planks, which are used for sleepers, doors, and windows, axletrees, &c. After the *pinho* or *araucaria*, the acacia which is known by the Indians as *curupay*, is one of the most useful woods of San Paulo. This wood is particularly hard and able to withstand the effects of the weather. It is used for carriage building, and for making drays and the rough carts of the country. The acacia is also employed in ship building and in making railway sleepers. This tree attains a height of from 12 to 15 metres, but it is of slow growth. Much interest is devoted to this tree, not only on account of the usefulness of its timber, but also because its leaves are said to have some medicinal property similar to that of the eucalyptus. Another interesting variety is the *guajuvira* (*Patagonula Americana*), a tree which is found growing throughout the whole of Southern Brazil. The wood is very hard and durable. It is eminently adapted to carriage making, and also furniture and other articles; it is also used for railway sleepers; it grows to a height of about 12 metres. The *soita cavallo*, or *açonta cavallo*, is a wood of very good quality, it is hard and not easily split. It is used for yokes, *sabots*, and broom handles. It also serves for piano making, and is used for furniture, and in one establishment on Santa Maria the *açonta-cavallo* is specially used for making chairs. In addition to the above-mentioned trees which are the most common, and the most generally used, there is a large number of other varieties, which although not worked, might be so with advantage and profit. There are the following: — *Cabreuva*, *ipé huma*, *canjerana*, *tajuba*, *jacaranda*, *figueira branca* (white fig tree); *aroeira*, *sucupira*, *pereira*, *batalha*, *canella*, *passaruiva*, *cedra*, *carroba*, *canna frista*, *suinam*, and others. The *cachocaen* and the *pas de Brazil*, which are found in great profusion in the forests, are much appreciated by dyers for the beautiful red colour yielded by the bark. An idea may be formed, by the above enumeration, of the abundance and variety of useful trees in the province of San Paulo. Unfortunately, as M. Georges Ritt observes, everything in Brazil is sacrificed to the coffee industry, all other productions only appearing to be of secondary interest. Sylviculture has always been neglected, and this to such an extent tha the neighbourhood of cultivated districts a l number of forests have been ruthlessly destroyed make way for coffee plantations. The conseque of this is the increasing rareness of indigenous wo on the market, and their high price. Moreove necessitates, in spite of the natural resources of country, a considerable importation of foreign tim particularly from Sweden and Norway and Califor these importations being required for building p poses. These foreign timbers, notwithstanding distance from which they are brought, are placed the market in Brazil at a cheaper rate than Brazilian woods themselves. One explanation of is that the high price of Brazilian wood is caused the difficulty and cost of transport in the interio the province. The majority of the railway compa only serve the coffee districts; in fact, it was in v of this industry that they were originally establish and it is, therefore, perhaps only natural that certain periods, more particularly during the co harvest, the companies devote all their energies to transport, which is a lucrative one for them, and t the carriage of timber is neglected, stocks of wh are allowed to accumulate and to remain for lo periods exposed to the inclemency of the weat and to the risk of robbery, which is by no mea infrequent. It is owing to these disadvantages, a the insufficiency of the means of transport, that t owners of the forests have been induced to destr their property rather than to saddle themselves wi heavy expenses which they could not recoup the selves for, by a rapid sale of their products. Mo over in San Paulo, although there are many strea and waterways, the advantages enjoyed in oth countries in the way of floating the timber to destination are not available, the streams in questi flow towards the western part of the province (t basin of the Parana), which is the sparsely-populat district, all the towns and the centres of indust and activity being situated in the elevated regions the interior, and at the source of the rivers. T virgin forests being found in the lower plains of t West, it is impossible to utilise the stream f floating the timber to the places where it could delivered for consumption. In conclusion, M. Ri says that unless the Government takes steps to p an end to the difficulties which hedge round t timber industry in Brazil, the time must soon co when an industry which could easily be made a inexhaustible source of wealth to the country wi entirely cease to exist.

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* For further information on these initial effects see "The
lternate Current Transformers," Fleming, new edition, vol.
p. 201. Also "The Electrician," vol. xxx., p. 543, L.
eustadt, "On Concentric Cable Phenomena."

NATIVE FABRICS OF ANGORA.

Home-made fabrics, which consist mostly of cotto goods, although some are of silk and a few of wool are manufactured principally in the following towns —Tocat, Marsovan, Amassia, Aidin, Broussa, Cas tambol, Aintob, Gurun, and Aleppo. Those whic ne from Tocat are made, so far as the warp is con- ned, of yarn imported from Europe, while that ich forms the web is of native manufacture, being stly made in Kharput. With the exception of the ast" reds, which are imported from Switzerland l Germany, such yarn as is imported is dyed in the ntry, native dyes being considered, and in the inion of the Acting-British Consul at Angora, htly considered, far more durable than those which me from Europe. The Consul has in fact been ured that coloured yarns imported from Europe not unfrequently re-dyed by the natives before they used. The fabrics consist chiefly of the following, native (Turkish) term being given, as that which best understood in the trade. *Aladja*—a some- at coarse striped cotton material, used by both n and women for various parts of their dress. *zma*—small printed muslin kerchiefs, worn as part the headdress by members of both sexes, the men nding it round their fezes, so as to form a sort of ban, while the women, more especially the Chris- ns, use it as a head covering both in and out of ors. This article, of which very large quantities now made in Angora, was at one time imported o entirely from Switzerland, among whose experts figured so conspicuously that it was considered specialty which defied competition from other arkets. Now it is made almost entirely in various rts of Asia Minor, and if it is not quite so good as e Swiss article, it is certainly much cheaper. *ushak* or "Cummerband"—a strong half cotton, lf woollen, material generally dyed red. *Amerikan* a coarse, plain, white calico, woven from English rn; is used by the natives of both sexes as the aterial for their underlinen. *Peshtamal*—a rough olly cotton fabric made up into an article, half wel, half apron, used for drying purposes in the tive baths. Those of the native-made fabrics, ich consist of silk, are imported mostly from eppo, although Broussa still sends a small quantity such goods yearly. In the case of both towns thing foreign enters into the composition of their k fabrics (except possibly the dyes, some of which imported from Europe), the silkworms being ared, the silk spun, and the material woven and ed on the spot. When completed it is made up ostly into various articles of female attire of the tter and more costly kind, though it is also used as material for men's vests. These native fabrics, en when made by the piece, are, without exception, ort and narrow, just sufficient in fact to supply aterial for a whole costume whether for a man or man, the difference between many of the essential rtions of the two costumes not being so marked in e east as in the west. The narrow width is owing the smallness of the native handworked loom.

CULTIVATION OF INDIGO IN MEXICO.

Indigo is cultivated in Chiapas, in Colima, in errero, Jalisco, Michoacan, and in Oaxaca. Three kinds are found, namely, *I. tinctoria, I. disperma, and I. ãnil.* The spring is the best time for sowing, and in the months of September and October the plants begin to flower, while in order to save the indigo in them, especially in the leaves, the stems are cut as soon as the yellow leaves appear on them, or the little buds begin to bloom. The substances which form indigo reside in the leaves, but the whole plant is subjected to the process of fermentation and agitation, by which the dye is manufactured. Two cisterns or vats are prepared, the first about 8 by 16 feet and 5 feet deep, and the second 12 feet square and 4 feet deep, and below the second a third may be placed, into which the contents of the second is run and allowed to stand for the dye to settle at the bottom. Unless, however, the operation is done on a large scale, the settling of the fluid can take place in the second cistern. Bundles (about 125 pounds each) of freshly cut plants are placed in the first cistern, and water is then run in so as to cover them to a depth of 3 or 4 inches from the top. A few hours after the introduction of the water it becomes turbid, then turns to a beautiful emerald green; the solution sets free carbonic acid gas, and traces of ammonia, and discoloured pellicles float on the surface. The fermentation generally lasts from 12 to 16 hours, and that according to the stage of the growth of the plant; if the plant is fully matured, going into seeding, the fermentation should last from 12 to 16 hours, but if the stems are cut when flowering, the maceration should be stopped in 10 or 12 hours. A sure indication as to the time when the solution should be transferred consists in the gas bubbles disappearing almost altogether, or when the solution, by rapidly stirring it in a glass vessel, forms small blue flakes which in a little while separates into granules. The solution, when run off into the second cistern is constantly agitated for a period of from 1½ to 3 hours. The liquor may be agitated by some mechanical contrivance, a hydraulic wheel, or by men going into the cisterns, beating and churning the fluid with wooden paddles. As the beating goes on the green liquor becomes of a deeper colour, violet, and then gradually turns to a very deep blue. Then a small quantity of a precipitant called "cuajo" or lime water is added in order that it may combine with the carbonic acid formed during the process of fermentation and help the precipitation by coagulating the fluid. This precipitant is prepared from a wild white grape called "olavere" found in the Isthmus of Tehuantepec and Chiapas, from a wild tree known as "quagatinta," and from the leaves of the marshmallow. After introducing the coagulating fluid the whole is stirred up, and then the colouring matter is allowed to settle and in two or three hours the indigo will have subsided in flakes and the amber coloured fluid will have remained on the top. This clear fluid is drawn off by means of the cocks until nothing is left in the cistern, but the indigo which looks like a bluish black mud. This mud-like stuff is then taken out and put into conical linen bag filters, which are hung up so as to allow the surplus moisture to drain away. The dye is afterwards taken out of the bags and placed in a large cement-lined kiln, where a gentle heat is applied until the whole is rendered dry. It is then subjected to hand-mill pressure, thereby formed into blocks stamped with the plantation mark and placed in heavy boxes, each holding 25 pounds. The actual cost of indigo raising amounts for the first year to 66 dollars 88 cents per hectare, and for the following years will be about 53 dollars. Thus a planter will have an annual income of 687 dollars per hectare (2·47 acres) by selling his indigo product at an average of 1 dollar per pound. The above information is obtained from the important report of Sir Henry Dering on the "Productions of Mexico."

PREPARATION OF CAVIARE IN RUSSIA.

Fishing is one of the most important branches of Russian industry. There is, perhaps, no other country in the world where fish plays such a leading part in the economy of life. In proportion to other countries, there are more people in Russia who, not being able to buy meat, have to depend upon fish for food. On fast days, of which there are so many, fish is an indispensable article for the whole nation. Russia has a large number of important rivers, streams, and lakes, besides a coast of 4,948 miles, which are rich in fish, with some rare and very fine species. The most valuable products of the fish industry in Russia are cod liver oil and caviare. Russian caviare is obtained mainly from sturgeon. In the Volga district, the white sturgeon leads for the high quality of its roe, and next comes the common sturgeon. The United States Consul-General at St. Petersburg says that although the preparation of caviare does not differ from that in other countries, its superiority being due to the fine quality of the roe, he has studied the process of its manipulation, which is as follows:—When a stranger is admitted into the fishing section where caviare is prepared, he finds it supplied with a number of troughs, wooden tubs, and vats, a stand, looking like a bench with upper frame open, on which is placed the freshly salted caviare in order to separate it from the superfluous brine. There is also a very important implement—the caviare press—with which the pressed caviare is prepared. On the walls hang the caviare sieves, consisting of wooden frames and nets of strong cords. The workmen separate the caviare from the egg bags, in which it is enclosed, by rubbing it with the hand through a sieve into a vat. The egg skin does not go through, but remains on the surface of the sieve. When fish are in the first stage of decomposition the egg skins get so soft that they can be separated from the roe, and from these the low grades of caviare are made. Next, in the salting of the caviare, it is salted only with brine made of fine salt. The difference in "fresh" caviare is ca by the smaller or greater quantities of salt conta in the brine, and this is regulated to meet the le of time the caviare is to be kept. The fresh bri kept in large wooden tubs, and the fine, clean used for the preparation of the brine is put small barrels. The superfluous brine is used ag Immediately after the eggs have been rubbed thro the sieves, they are put through the brine, an soon as they are deprived of the superfluous they are placed in tin jars or cans and small woo kegs; and the so-called fresh caviare, which is priced, is ready for market. The cheaper kin cured in the brine and then put into linen bags pressed. This is called pressed caviare. The should not be taken from the fish before the thir fourth year, when it is ripe, and grown to its full s Many fish are cut before the roe is ripe, and in s case the roe must be used immediately. This is reason why fresh caviare can be obtained at times. During ten months of 1895 Russia expo 4,658,448 pounds of pressed caviare and 613, pounds of fresh caviare.

CONSUMPTION OF CHEMICALS IN ITALY.

Quinine is the principal drug employed in med prescriptions in Italy, and the reason of this will obvious to anyone who has studied the so-cal "fever map" of the country, which displays large and numerous districts infected by mala Consul Neville Rolfe, of Naples, in his last rep says that the sulphate, bisulphate, hydrochlor and valerianate are the principal quinine salts general use, and of the many qualities in the mark Howard's brands are chiefly in favour with med practitioners and command the best prices. quinines other than those of British manufactu those of Zimmermann and Braunschweig have most regular sale. Iodine is a product of whic large quantity is used especially in the form of iod of potassium and sodium, of which the best are British manufacture. Mercury, zinc, morph bromide of potassium, bromide of sodium, salic acid, and especially the salicylate of sodium, caffei cocaine, and pepsine are largely employed. To th may be added boracic acid, tannic acid, tartaric ac alum, bicarbonate of sodium, cream of tartar, ca phor, gum acacia, chlorate of potash, precipitat chalk, starch powder, carbonate of magnesia, a effervescing citrate of magnesia. The latter article manufactured on a large scale in Italy, though Bishop preparation is considered the best. There are ma modern chemical preparations, mostly of Germ origin, which command a rapid sale in South Ita such as antipyrrhine, phenacitine, dormatol, diareti migrainine, and many others, while creosote, gajac and turpin hydrate are in constant demand. aromatic essential oils, Mitcham peppermint a

ham lavender have the first place, and together
. British Indian sandal-wood oil have a large
. So, too, have cod-liver oil and essence of
entine. Since the publication of the first official
an pharmacopeia, in 1892, extracts and tinctures
e British pharmacopeia are no longer in demand
Italian chemists, but fluid extracts are still readily
able. The drug trade is limited to Carlissaia
, opium, nux vomica, sarsaparilla, senega root,
, and senna leaves, which are imported on a
e scale. The provisions of the new Italian sani-
laws have created great difficulties in the way of
sale of British patent medicines and proprietary
cles. A circular from the Ministry of the Interior
d June 16, 1890, which circular is now in opera-
, provides that no medicine of which the com-
ent parts are not known shall be exposed for sale,
ther it be a foreign product, or one compounded
taly.

IMMIGRATION INTO BRAZIL.

he tide of immigration into Brazil was very strong
year, the number arriving at Rio being 94,580, or
47 more than in 1894. In reply to numerous
uiries that have been made to the Consulate at
, Consul Wagstaff says that intending emigrants
Brazil have been strongly advised to give preference
British Colonies, Canada, the United States, or
ith Africa. Emigrants undergo terrible hardships
n the time they leave their homes until they reach
de Janeiro, where they are landed at Ilha das
res (an island in the Bay), which offers accommo-
ion for about 1,500 persons, though 2,000 to 3,000
sometimes quartered there under insanitary con-
ons. The rate of mortality amongst children has
ly been very high there. Immigrants are sup-
ed to remain there ten days or a fortnight, but
y sometimes remain two to three months. There
lso a station at Pinheiro (State of São Paulo)
re the immigrants are also subjected to great in-
veniences. During the period from 1890 to 1895
,286 emigrants passed through the depôt at Ilha
Flores, of whom 136,262 shipped independently,
remainder having come on contract signed in
rope. Only 124,071 of these persons landed for
tlement in Rio de Janeiro. The emigrants best
ed to the condition of life in the Brazilian climate
Italians, Spaniards, and Portuguese. Large num-
s of Austrians also arrive. The first named go to
coffee plantations in the States of São Paulo,
irito Santo, and Minas Geraes; the Spaniards
l Portuguese to the Northern States, where sugar,
ton, and tobacco are raised; they also settle in the
te of Rio de Janeiro and the Austrians in Paraná
l Santa Catharina. The most healthy States are
he south, where the same system of agriculture is
sued as in Europe, producing cereals and wine,
l in Rio Grande do Sul, tobacco also. Settlers in
se districts are better off than those in other provinces, but the absence of roads for marketing produce is a serious hindrance to improving their position. Finally, when the immigrants are definitely settled, their condition, especially in the coffee districts, is a hard one, and they seldom become the possessors of land. After deducting cost of living, rent, and use of implements from their share of the crops, the savings are exceedingly small.

THE MANUFACTURES OF VENEZUELA.

Venezuela is essentially an agricultural country, its factories are few, often of the crudest kind, and devoted to the manufacture of the most pressing wants, such as sole leather, soap, candles, matches, cigarettes, rum, native shoes (*alpargatas*), hats, and sugar. The manufacture of sole leather, according to the United States Consul at Puerto Cabello, appears to have acquired an impetus and support for which its large consumption and the high duty thereon seems responsible. Puerto Cabello supports two tanneries. As Venezuela exports large quantities of goat and deer skins and hides, suitable for uppers, the Consul suggests that it might be profitable for some large tannery belonging to a country outside Venezuela to establish a branch there for the purpose of preparing and exporting these articles. The duty on manufactured leather being at the rate of 4 dollars per kilogramme (2·2 lbs. avoirdupois) and on the unmanufactured 50 cents per kilogramme, the poor people are practically debarred from its general use, and confine themselves, for ordinary wear, to the native *alpargata*, a modified scriptural sandal, composed of a solid piece of sole leather, shaped for the foot, with a woven cotton upper, having an outlet for for the big toe, a piece of similar material secured to the leather heel, and then passed over and fastened to the upper part of the heel of the foot. The importation of sugar being prohibited, all large cane plantations have their sugar mills, with more or less advanced processes for placing the product on the market, but no refinery exists in Venezuela. Soap is made from native cocoanut oil, and candles from stearin imported from Europe. Both industries are not only among the most profitable, but also of the greatest magnitude in Venezuela, the high duty giving them a monopoly in the common classes of these articles. Fancy and perfumed soaps are not manufactured. Rum and cigarettes are made from native products. Tobacco of excellent quality is grown and employed in the manufacture of cigarettes, together with a considerable quantity of Cuban tobacco. Both industries are fairly profitable. The *alpargata* (shoe) is manufactured or, rather, put together by numerous small factories, the woven cotton being usually purchased from the large factory in Valencia, which makes a specialty of this article.

General Notes.

COMMERCIAL MUSEUM IN BREMEN.—The *Stadtisches Museum* of the city of Bremen has recently been opened to the public. It is an industrial, commercial, and historical museum. In addition to ethnographical, ornithological, botanical, and ichthyological collections and plans, and models of Bremen maritime construction, the city has classified according to countries of origin, the productions of the various countries with which its trade has special relations. The permanent exhibition of Bremen is still in course of formation, and its director has expressed a desire to receive articles for exhibition from foreign countries.

EXTENSION OF RAILWAYS IN GERMANY.—The United States Consul at Chemnitz, in a recent report on German railways, states that in eleven years (1885-1895) the Empire has seen its railways increased from 22,704 miles to 27,445 miles — an increase of 4,741 miles. In 1885, 18,915 miles belonged to through or principal lines, with 3,789 miles branch lines; while in 1895, 19,658 miles were on through lines, with 7,787 miles on side lines. The total length of rails in 1895 was 48,155 miles, an increase of 10,626 miles over 1885, and 967 miles over 1894. There were in 1895, 9,457 miles of double track lines, and 17,988 miles of single track lines—a ratio of 1·9 to 1 in favour of the single track lines. In 1885, the ratio was 2·4 to 1, hence in the last ten years the double track has found favour. There are 66 miles with three tracks, and 41 miles with four tracks.

CHINESE WINES.—According to the *Handels Museum*, a well-known Chinese firm intends to open in Northern China a large establishment for the production of wine. The vine has long been grown in that country but only with a view to producing grapes for the table. Attempts were made in 1893 to produce wine and even champagne from these grapes; these attempts were so successful that the firm referred to has applied to the Chinese Government for a monopoly for the production of wine from grapes. An Austrian expert has recently visited the vine-producing districts of Northern China, and describes the quality of the grapes grown there as excellent. Baron Max von Babe, son of the late director of the Austrian Pomological Institute, has been appointed director of the new establishment in China, and is now, it is stated, on his way to that country.

THE SERVIAN WINE INDUSTRY.—According to recent statistical returns the cultivation of the vine in Servia shows a considerable decrease. In the year 1889, the area of the vineyards amounted to 106,253 acres, with a production of 22,000,000 gallons, which represented a sum of over £760,000. In the year 1892, the phylloxera had already destroyed over 27,000 acres, and as no preventive measures were taken to check its ravages, it progressed rapidly year to year until at the present time over 49 acres of the former vineyards have been aband as totally unproductive. Consul Hammond says the renowned grape of Negatin and Semendria become extinct. Servia, besides its own consump used to export about 1,500,000 francs worth of but she now has to import more than double amount to cover home consumption. The replan of the destroyed vineyards with American vines been very much neglected, and in the whole Servia there has scarcely been more than 100 a regained for the cultivation of the vine.

POSTAL DEVELOPMENT IN JAPAN.—Accordin a recent Japanese report, there has been a remark development of postal business since the conclu of the war with China. Until the year before l the number of postal cards and stamps purchased the people did not average more than 170,000, per year — the figure of 200,000,000 was ne reached. From 1894, however, a great increase taken place. Last year the postcards and stan marked in various post-offices aggregated 300,000,0 and at present the daily rate is about 1,200,000, even 1,400,000 on special days. The postcards printed at the Insatsu-Kyoka (Government Print Bureau), and thence forwarded to the Department Communications, and if there is the slightest hitch the process, great inconvenience results. From same bureau were issued also the pass-books for Post-office Savings Banks. For many years number of these required remained at an average from 400,000 to 600,000 annually, but last year figure rose to 800,000. As for postage stamps, daily total now printed off, irrespective of denomi tions, is about 600,000.

GERMAN GLASS INDUSTRY.—According to *Handels Museum* the glass industry of Germany be divided into two groups, the one including wor which produce glass out of the raw material, while the second group belong those factories which rece glass from the former, and improve it by blowing a cutting. At the present time there are 312 act glass manufactories in Germany with 50,000 *employ* In these factories glass and glass wares are produc for consumption, such as bottles and other holl glass, mirror and window glass. Of these factor 187 are in Prussia, 54 in Bavaria, and the remaind in the other German States. To the second group this industry belong 163 establishments with 9,0 *employés*, so that the total number of factories pr ducing and improving glass in Germany is therefo 475. Of these 241 are in Prussia, 108 in Bavaria, in Saxony, and the remainder in the smaller Germ States. The glass industry of Germany has to co tend against a very keen competition with Austri Hungary, Belgium, and France, all these countrie owing to advantages obtained by their commerci treaties with Germany, being able to import into t latter country large quantities of glass and glass ware

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l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the othergill prize of £25 and a silver medal for paper on "The Best Means of Effectually reventing the Leakage of Current to Earth in lectrical Installations from Generating Heat id Setting Buildings on Fire." The paper iould consist of about eight thousand words, id be written with a view to being read id discussed at an ordinary meeting of the ociety.

Papers submitted for the prize must be sent the Secretary on or before 1st of October, 96. Each paper must be typewritten, and ear a motto, the name of the writer being iclosed in a sealed envelope with a similar iotto. The judges will be appointed by the ouncil.

The Council reserve the right of withholding ie prize or of awarding a smaller prize or naller prizes, if in the opinion of the judges o essay deserving the full award is sent in.

RIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are repared to award, under the terms of the enjamin Shaw Trust, a Gold Medal, or a rize of £20.

The medal, under the conditions laid down y the testator, is to be given "For any disovery, invention, or newly-devised method for bviating or materially diminishing any risk to fe, limb, or health, incidental to any indusial occupation, and not previously capable of eing so obviated or diminished by any known nd practically available means."

Intending competitors shall send in descripons of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Miscellaneous.

IRON AND STEEL WORKS OF THE UNITED STATES.

The following information respecting the development and present number of works and manufacturing plants in the iron and steel industries appears in the "Directory of Iron and Steel Works" recently issued by the American Iron and Steel Association, and is quoted from the *Engineer*:—

Blast Furnaces.—In 1876 there were 713 blast furnaces active or in preparation, with an aggregate annual capacity of 4,856,455 gross tons. In 1892 there were 569 furnaces, 14,550,708 tons capacity. In 1894, 519 furnaces, 16,271,027 tons capacity. In 1896 there are 469 furnaces, but their aggregate capacity is 17,373,637 tons, the steady decrease in numbers of furnaces being more than balanced by the increase in capacity of output. Thus in 1876 the average capacity per furnace was 6,811 tons per year, while in 1896 it is 37,044 tons. These figures indicate a very great change in furnace construction and management. Severe competition, better methods of manufacture, better ore and fuel, favoured manufacturing localities, the constant tendency to lower prices, and the crushing effects of the panic of 1893, have combined to put the manufacture of pig iron in few and strong hands. There are 10 new furnaces in a more or less advanced stage, while 14 others have been commenced, but work upon these latter has been temporarily suspended. The four new Duquesne furnaces of the Carnegie Steel Company will be the largest in the world, 100 feet high and 22 feet wide at the boshes, the aggregate annual capacity being 700,000 tons. Of the 469 furnaces now in operation, 96 use charcoal as fuel—as compared with 118 in 1894—and 373 use anthracite and bituminous coal and coke—as compared with 401 in 1894. The charcoal furnaces have an annual capacity of 1,098,550 tons, while those in 1894 had a capacity of 1,285,400 tons, the average capacity per furnace being 11,443 tons in 1896, and 10,894 tons in 1894.

Rolling Mills and Steel Works.—There are now 505 completed rolling mills and steel works, of which 463 have trains of rolls, and 42 have no rolls. Since 1894, there have been 41 new works built and 22 abandoned. In January, 1896, there were five works in course of erection.

Puddling Furnaces.—The number of puddling furnaces in connection with rolling mills—double furnaces being taken as equivalent to two single furnaces—is 4,408, against 4,715 in 1894. The greatest number of these furnaces was in 1884, when 5,265 were in operation; while 5,120 were still in existence in 1892, but since that year the number has steadily declined.

Bessemer Steel Works.—There are now in operation 44 standard Bessemer steel works, with 99 converters—including one small converter of 1,000 lb. capacity for steel castings by the Walrand-Legenisel process—as compared with 43 works and 95 converters in 1894. The total annual converting capacity is 9,472,350 tons of ingots and direct castings, against 7,740,900 tons capacity in 1894. Few direct castings are made at Bessemer steel works. There are three Clapp-Griffiths steel plants and three Robert-Bessemer steel plants, aggregating 10 converters, but these are not all in operation. Since 1894, there have been five new standard Bessemer works built, and four abandoned.

Open-hearth Steel Works.—There are now 88 completed open-hearth steel plants, and four in course of construction; the total capacity in ingots and direct castings being 2,430,450 gross tons. In 1894, there were 81 plants, with an annual capacity of 1,740,000 tons, but since then 11 new plants have been established while four have been burned or abandoned. There are 35 plants equipped for making direct castings, as compared with 28 in 1894, while another plant for making open-hearth steel castings is now being built. The manufacture of steel castings has grown so rapidly within late years that it has wrought a great change in general foundry practice.

Basic Steel.—During the past two years rapid progress has been made in the manufacture of basic steel, but it is wholly confined to works which have open-hearth steel plants. A number of these works make basic steel regularly, while some make it almost exclusively. In all, about half the open-hearth steel works which produce ingots now make basic steel. The manufacture of basic Bessemer steel has no existence in this country, but the Troy Steel Company proposes to make it with three 15-ton converters at its new works on Breaker Island.

Crucible Steel Works.—There are now 45 crucible steel plants, with an aggregate annual capacity of 98,700 gross tons. In 1894 there were 48 plants, and since then eight have been abandoned and five built.

Cut Nails.—In January, 1896, there were 53 rolling mills devoted in whole or in part to the manufacture of cut nails and spikes, with 4,589 nail machines. In 1894 there were 55 mills and 5,094 machines, while in 1892 there were 65 mills and 5,546 machines.

Wire Nails.—There are 53 completed works, and one plant to be rebuilt, the capacity being very much greater than that of 54 completed and one par completed works in 1894.

Wire Rods and Wire.—There are 23 wo equipped for rolling iron and steel wire rods, the sa as in 1894; while there are 73 iron and steel wi drawing plants, as against 64 in 1894.

Plate and Sheet Mills.—These are included in t rolling mills and steel works. There are 156 co pleted plants, three in course of erection, and t partly completed. In 1890, before the tin-pla industry had obtained a foothold, there were 1 plate and sheet mills, and three in course of erectio Most of the new mills since that time have be designed to meet the demand for black plates tinning and terne plating, and many of the mi which were in existence in 1890 have been enlarg or changed to meet the same demand. There a now 41 rolling mills specifically named as maki black plates for tinning, while three works of simil character are in course of erection. The armou plate works are included with the plate works, a for over two years they have fully met the exacti requirements of the Government for the supply armour plate for the new Navy.

Tin-plate Works.—There are now 69 complete works, four in course of erection, and one is bein rebuilt. Practically all these works have been bui since the passage of the Tariff Act of 1890. In 189 bright tin-plates were being manufactured at thr works, terne plates were manufactured at anoth plant, and two tin-plate works were in course erection. In 1892 there were 20 works making tin plates or terne plates, and 10 works were in course erection. In 1894 there were 56 completed works and three in course of erection.

Forges and Bloomeries.—This classification includes only the works which have wrought iro direct from the ore, and works which have bloom from pig iron or scrap iron for sale. Works whic make blooms in connection with rolling mills, and fo use exclusively in these mills, are not separatel classified, as they are auxiliary and not independen works. There are now 23 forges and bloomeries—most of which are pig and scrap forges—as agains 25 in 1894. In the South, where formerly there wer hundreds of Catalan forges making small quantitie of wrought iron directly from the ore, there is now only one active forge of this character left. In New York there are only seven forges making iron directl from the ore, while in 1876 there were 27 such forges.

Miscellaneous Works.—The following are the number of works allied to the iron and steel industries:—Stamping works, 27 completed and one being rebuilt; iron and steel bridge building works, 74; iron and steel shipbuilding yards, 36; horseshoe nai works, 13; malleable iron works, 82; cast iron and cast steel pipe works, 70 completed and one being built; wrought iron and wrought steel pipe, riveted pipe and seamless tube works, 38 completed and one being built; locomotive works, 22; car works, 112;

wheel works, 112 completed and one partly ted; car axle works, 64 completed and two being lt.

Vatural Gas.—There are 89 completed iron and l works using natural gas in whole or in part, of ich 61 are in Pennsylvania, 22 in Indiana, 5 in io, and 1 in West Virginia. One Indiana plant v being built will also use gas. The total conption of natural gas in works of this character is wing steadily less every year.

TREATMENT OF GOLD ORES IN AUSTRALIA.

The United States Consul-General at Melbourne, a recent report to his Government, has given a full ount of the treatment of gold ores in Australia. e veinstone, which contains from 1 to 12 per cent. pyrites, but generally only from 3 to 5, is crushed t in stamper boxes. The crushed material passes ough stamper gratings, containing from 81 to 290 les to the square inch, and is, as a rule, delivered the amalgamated copper plates and mercury wells nches deep at the back of the slide board and 2 hes in front of it, or simply on to plates having ly mercury riffles; thence by gravitation on to nket strakes or Halley's percussion tables or zigg boxes; if on to blankets, thence on to Halley's le; but if on to Halley's table, thence on to nket strakes; and if on to a labyrinth of zigzag xes, thence into a buddle. In the first of these ree cases the pulp collected on the blanket sand d the refuse from the same, together with the tails, concentrated in a Duncan concentrator, or amalgaated in a revolving barrel, and from the barrel is en pumped into an inverted pyramidal box, whereby slimes are, to a great extent, separated from the arse sand, which is at once treated on vanners, ile the slimes are collected in large settling tanks, d then treated on vanners. At times, without ncentrating it in a Duncan concentrator, or ating it by amalgamation in a barrel, the lp being very poor in pyrites, the tail sand m the end of the blanket strakes is pumped into several pyramidal boxes, when the coarse nd and the slimes are treated on separate vanners. ith the concentrates thus obtained, the blanket nd is treated by chlorination. Again, in some tances, though seldom, wooden strakes (boxes) d tyes are placed at the end of the blanket strakes, d thereafter, lastly, a canvass table. In another ishing establishment, the pulp from the blanket akes is concentrated in percussion tables (Halley's), tailings from which flow into a sump. A tailings mp lifts the pulp on to a high platform, where it is tributed without classification, on two long, fixed, eefold canvass tables, each about 110 feet in length. though not treating veinstone only in one of the gest reduction works in Victoria, the tailings from the blanket strakes, which are placed immediately below the amalgamated copper plates, flow into a pit and are raised thence and delivered into a trommel. The pulp passing through it is then classified in a long series of Spitzkasken (inverted pyramidal boxes), and the different grades obtained by that means, are then concentrated on a number of Luhrig runners. Lately, the overwork of these has been somewhat relieved by the introduction of a great number of what may be termed endless intermittently revolving canvass vanners, about 120 feet in length, as they concentrate on a wooden platform during about a quarter of an hour, more or less, according to the mineral contents of the pulp, and are then made to revolve on rollers a length of about 18 feet, to enable the concentrates gathered on the upper portion of the canvass belt to be washed into the collecting trough. The "blanket sand" in that establishment is treated with a large quantity of mercury in what may be called a large Berdan basin, but without balls or drag. In the second of the three cases above mentioned, the Halley's table having concentrated a large per-centage of pyrites, mainly the coarsest particles, the pulp falls by gravitation on to blanket strakes; thence, without further classification, on to free vanners; thence into wooden strakes; and finally, before running to waste, it is passed over canvass frames. In other instances, the blanket sand collected at the end of the percussion tables is concentrated by a Duncan concentrator, and the tailings from it flow into the battery tailings sump, and thence the whole is pumped into a slime-separating inverted pyramidal box. The coarser materials issuing from the apex is at once concentrated on Triumph vanners, while the slimes conveyed into settling tanks are subsequently dressed on different vanners of the same type. Finally, the whole of the tailings pass over canvas frames. Other reducing plants convey the blanket tailings directly by gravitation to the head of a series of wooden strakes and tyes, then pump them on to a platform, and then in some cases distribute the pulp, without any attempt at classification, on to fixed canvass tables. Referring to the third method of treatment noted, the crushed material flowing from the end of the amalgamated plates into zigzag boxes is roughly classified in them. The "heads" and "middles" are concentrated in a Borlase concave buddle, fitted with iron scrapers set at an angle, but the tailings from the labyrinth and those of the buddle are collected in a sump, and thence raised by a tailings pump on to, and distributed over, an extensive area of blanket strakes. The large quantity of rich sand collected from the sluicing of the blankets, is concentrated by a McNeill's oscillating convex concentrator, which collects a considerable quantity of mercury and amalgam (gold amalgam), separating it from the iron and arsenical pyrites (concentrate), and this from the sand which flows back into the pit. The tail sand from the fall of the blanket strakes is conveyed by a launder into an inverted pyramidal box, whence the coarser pulp escapes at the apex, and is at once treated on

Triumph vanners, while the slimes flow into another inverted pyramidal box, from the apex of which the heavier stuff (classified) is delivered on to slime vanners, and the overflow is concentrated on to a fixed canvass table about 30 feet in length. The foregoing is a precise statement of the methods and appliances generally adopted on the principal works in Victoria to extract the gold from the matrix. There are, however, a few establishments in which the treatment of the auriferous veinstone is differently effected. For instance, those in which the pulp, dropping from the end of the amalgamated copper plates, flows at once into a Denny and Watson grinding and amalgamating pan, or other similar appliance, to effect the same purpose, the overflow from which is allowed to run to waste, and the one establishment in which the veinstone is comminuted in a ball mill (kugelmühle), and the escaping pulp is treated more or less in the usual manner. The concentrates obtained by the stamp-mill process, which consists generally of a mixture of arsenides and sulphides, arsenical pyrites, iron pyrites, and a slight admixture of galena, zinc blende, &c., are roasted in either long (about 45 to 60 feet), slightly inclined furnaces, or in 12 to 14 feet high revolving furnaces, until most, if not all, of the iron contained in the concentrates has been oxidised to the state of sesquioxide of iron. The roasted ore is then, according to the grade of the particles of the gold therein, either subjected to the process of amalgamation or treated by chlorination. In some establishments the well-known Newberry and Vautin process is adopted, while in at least one mill, the system of open vats is adopted, as at Mount Morgan, in Queensland. In both cases the gold is precipitated from its solution on charcoal by percolating it through charcoal filters. As an exception to the usual course of roasting the concentrates (pyrites) before the gold is extracted by amalgamation or chlorination, 112 tons of clean iron and arsenical pyrites were treated a few years ago by amalgamation by, first of all, grinding the pyrites in a Chilean mill to an impalpable pulp, then passing it in a diluted state through the force dollies charged with quicksilver, and thence in several sets of Rittinger's Hungarian mills, the whole of their working surfaces being covered with amalgamated copper plates and the basins charged with mercury. The result was very satisfactory, as the yield exceeded that obtained from the amalgamation of the roasted stuff, but the process was too slow, only from 12 to 15 tons per month, per heavy Chilean mill, being put through. The actual loss of gold on an average, in the treatment by open vats of concentrates averaging, as per assay, 6 ounces of gold to the ton, is 2 pennyweights of 23 carat gold to the ton, *i.e.*, the gold saved equals 98·34 per cent. of the assay value. In another large establishment, in which the concentrates are treated by the Newberry-Vautin method, the loss of gold per ton averages 6 pennyweights from concentrates averaging, as per assay, 3 ounces 11 pennyweights 3 grains to the ton,
i.e., the gold saved is equal to 91·66 per cent. of
assay value. The cost per ton for treatment in
first case is £1 4s. 2d.. and in the second £2 0s.
Very few mining companies extract the gold from
concentrates in their works. Most of them eit
sell them to the amalgamating, chlorinating firms
Bendigo or Ballarat, and other centres of large fiel
or have them treated at those establishments
account.

INLAND NAVIGATION IN GERMANY.

Now that the network of railroads in Germany
been completed, as far as the main roads are cc
cerned, public attention is principally turned towar
inland navigation, and the question of canals cc
nected therewith. Sir Charles Oppenheimer, H
Majesty's Consul-General at Frankfort-on-Mai
says that a new inland navigation law came in
force on the 1st January last, which regulates
detail all the conditions of inland navigatio
Authority has been granted to the Government
regulate the rules regarding the time of loading,
discharging, waiting, &c., and of fixing the charg
for the time of same for certain harbours, whi
deviate from the general tenour of the law. It ha
moreover, decreed that ship registers are to be kep
River navigation has made great progress in Germa
during the last decade. In the harbours of t
Rhine the traffic has risen from 21,300,000 tons,
1893, to 24,600,000 tons in 1894, *i.e.*, by 15 p
cent. At the 34 German Rhine harbours, the traff
rose at the same time from 14,600,000 to 16,700,0
tons. The most important Rhine harbours
Germany showed the following traffic in 1894:-
Ruhrort, 4,693,198 tons; Mannheim (Rhine an
Neckar), 3,662,580; Duisburg, 2,579,738; Hoc
feld, 958,105; Ludwigshafen, 754,426; Cologn
637,216; Gustavsburg, 500,283; Dusseldorf, 354,823
Castel with Amöneburg, 317,197; Mayence, 244,64
Neuss, 209,000; Worms, 173,200; Uerdinge
159,695 tons. Efforts which have for their obje
the completion of the construction of inland wate
ways were very active during the year 1895. At th
head stands the Midland Canal, as in 1886 th
Prussian Diet sanctioned the Dortmund-Ems Cana
but refused in 1894 to have it continued as far as t
the Rhine. The Dortmund-Ems Canal already
paying attention to larger ships; it possesses a dept
of 2·5 metres and is intended for vessels of 600 or 70
tons, but is so constructed that ships of 800 to 1,00
capacity will gradually be admitted. The Midlan
Canal is to unite the Rhine, Weser, and Elbe wit
each other, and is to meet the requirements of th
present day shipping. It is to branch off at Beve
gern, north of the Teutoburg Forest, in an easterl
direction from the Ems Harbours, and is to reach th
Elbe in the direction of Osnabrük, Minden, Hanove
Lehrte, through the Drömling below Magdeburg
below the mouth of the Planen Canal. The Midlan

nal will therefore not only bring about the uniting
the Rhine and the Rhenish-Westphalian mining
l industrial centre with the Elbe, but also by
ans of the Planen Canal unite with the Markish
trict rivers, the centre of Berlin, and by these unite
h the Oder, and by means of the network of the
omberg Canal and the Brahe bring about the
ting with the Weichsel. With its completion
re thus exists a navigable way from the west to
east of Prussia, although indeed not quite uniform
oughout, and from the coal and iron districts of
enish Westphalia, up to the eastern districts pro-
cing breadstuffs, wood, and other agricultural and
est products. Next to the possibility of uniting
h very important centres like Osnabrück, Minden,
nover, Brunswick, Hildesheim, Magdeburg, by
ans of canals directly with the waterway running
m west to east, Bremen now enjoys the prospect
obtaining an efficient water connection with middle
d western Germany by the canalisation of the Weser
far as Merseburg, and the building of a canal from
nce to the Midland Canal, which it had hitherto
do without, on account of the deficient depth of
ter in the Weser. The length of the entire line
m the Rhine to the Elbe will probably be about
5 kilomètres (295 miles). The canal would benefit
ecially the wood and coal trade; it is expected
at Westphalian coal will then become considerably
eaper in North Germany (Berlin), &c., and that
s Silesia as well as English coal will be driven
m the market there. The canal would also be of
portance for the traffic in grain, iron, stone, cement,
gar, fertilisers, hay and straw, beet, potatoes, &c.
e Oder Elbe Canal, traversing Lower Silesia, has
eady been planned in Silesia in order to open a
w field of output for the coal there. The question
canals is also to the front in South Germany. In
first place may be mentioned the canalisation of
e Main from Frankfort to Offenbach, as to which
understanding between the Governments of Prussia
d Hesse has now been effected, and then the same
Offenbach to Bavaria, as Bavaria has already
ntinued the chain lying in the bed of the Main at
e expense of the State as far as Kitzingen. The
varian Diet however refused to grant the costs of
e preliminary work for the Main Danube Canal. It
n scarcely be doubted, says Sir Charles Oppen-
imer, that this sum will eventually be granted, since
o in Bavaria a society has been formed for the pro-
otion of canal construction, among the chief sup-
rters of which may be counted the future successor
the Crown. The Main Danube Canal would con-
ct the North German network of canals and rivers
th Bavaria, Austria, and the lower countries of the
anube, and would thus bring the entire canal system
completion.

THE SUGAR INDUSTRY OF PERU.

The first sugar cane planted in Peru came from exico, and the first sugar haciendas appeared at Huanuco, and soon after at Peru, where cane culture was rapidly extended. The product was gradually exported to Guayaquil, Chile, and Buenos Ayres, when the increasing demand led the planters to introduce slave labour for its production. This was followed, three centuries later, by the importation of Chinese labour. In 1835 the first exportation of sugar was made from Peru to Europe, from the port of Cerro Azul, in the brig *Pacifico*, of 280 tons. At the present day, cane culture extends along the entire coast of Peru, from the third to the eighteenth degree of latitude. La Noria, on the Tumbes river, in the Department of Piura, is the northernmost hacienda. It produces 125,000 kilogrammes (kilogramme = 2·2 pounds) of sugar, and a great quantity of spirits annually. The United States Consul at Callao says that next in order of importance are the haciendas of Tina and Anchalay, in the province of Ayabaca, on the left bank of the Macara river, which is the boundary of Ecuador. They make but little sugar, the output being *chancaca* (refuse left in the boilers), or concrete. The same may be said of the haciendas of Curilcas, Cachaco, and San Pablo. The quantity of sugar annually produced by these five haciendas may be estimated at 100,000 kilogrammes. In the districts of Frias, Santo Domingo, and Ayabaca, where property is greatly subdivided, there are numerous *chacaritas* (small farms), where the juice is made into spirits. In the province of Huancabamba, the haciendas of San Antonio, Huarimal, and Tumas, each make about 25,000 kilogrammes of chancaca annually. The annual produc- of sugar and chancaca, in the department of Piura, may be set down at 250,000 kilogrammes. In the department of Lambayeque are the valleys of Chiclayo and Lambayeque, where are situated the haciendas of Pomalca, Pucala, Tuman, Patapo, and Almendral, producing in all 5,400,000 kilogrammes of sugar. There are other districts where cane is ground on the primitive vertical mills (*trapiches*) worked by animals. Chancaca is the chief product of these places, and it is roughly estimated at 1,000,000 kilogrammes annually. Altogether the rich department of Lambayeque produces annually 10,000,000 kilogrammes. Next is the department of La Libertad, which is second only to the department of Lima in sugar production. The province of Pacasmayo produces 2,750,000 kilogrammes of sugar annually. The province of Trujillo, where the famous valleys of Chicama, Santa Catalina, &c., are situated, is the principal sugar-producing centre. Its production last year was between 20,000,000 and 23,000,000 kilogrammes. In the department of Ancachs and valley of Santa, the chief haciendas are those of Vinzes, Suchiman, Puente, San Jacinto, and San Joseé. The total yield of the department is about 4,200,000 kilogrammes. The facilities and advantages offered by the capital have given to the department of Lima the first place in the production of sugar, as is shown by the fact that it amounts to an average of 30,000,000 kilogrammes annually. In the department

of Ica the principal haciendas are those of Chinca, Laran, San José, Caucato, and Trapiche. The total production of this department averages 2,700,000 kilogrammes. The department of Arequipa produces about 1,400,000 kilogrammes, the department of Moquegua 10,000 kilogrammes, and the department of Tacna 250,000 kilogrammes. The production, therefore, of the whole coast region comprised by the above-mentioned departments is about 72,000,000 kilogrammes, and the extent of land devoted to the sugar industry on the coast of Peru is about 111,155 acres. As regards the interior region of the country, the sugar industry is carried on in the deep warm gorges found in the mountain ranges, and with the exception of the small quantities which are exported to Bolivia, or conveyed to the northern departments, the products are for local consumption. Necessarily, the sugar industry of the interior is far less extensive than that of the coast, by reason of the difficulty of transporting the product to the ports. In the department of Cajamarca, cane cultivation is nowhere the exclusive industry of the haciendas. The production is mainly rum and chancaca for local consumption. The quantity of chancaca made in this department is estimated at 450,000 kilogrammes. The province of Huanuco, in the department of the same name, has the haciendas of Quicacan, Vichaycoto, Andadamba, Canchan, Huacho, Huanchacupa, Mitupampa, Yaucan, La Esperanza, Culcuy, and Despensa, all producing sugar, chancaca, and spirits. The total production of sugar amounts to 1,000,000 kilogrammes. The province of Angaraes, in the department of Huancavelica, makes 25,000 kilogrammes. The department of Ayacucho makes 30,000 kilogrammes. The department of Apurimac has excellent lands for cane culture, and the haciendas on the banks of the Pachachaca were formerly renowned for their product. They produced 400,000 kilogrammes. The eighteen haciendas in the province of Abancay make about 150,000 kilogrammes of sugar or chancaca. There are twenty-nine haciendas making cane in the province of Andahuaylas. The total production is about 200,000 kilogrammes. Cane is grown in the provinces of La Convencion and Calca in the department of Cuzco. In all 25,000 kilogrammes of sugar are made. The region of the interior produce altogether 1,730,000 kilogrammes. In the immense slopes and plains crossed by the great streams whose waters make their way by the Amazon to the Atlantic, cane culture has attained but little development, although the fertility of the soil and the grandeur of the forests abounding with riches, excite the admiration of all. Along the banks of the great rivers the mean temperature is 74° Fahrenheit. The cane matures annually and in some sections every nine or ten months. It generally attains a height of about ten feet and lasts from fifteen to twenty years. The juice is abundant, but it contains only from 7° to 8° Baumé of saccharine matter, in rainy years but 6°. Of late years modern machinery has been introduced by which excellent sugar is made. Most of the juice is made into spi
The principal hacienda—Juan de Almonte,
Yurimayuas, in the vast department of Loreto
supplied with modern machinery and turns out ex
lent white sugar. Cane culture is very limited in
department of Amazonas. The department of J
produces a considerable amount of sugar. In
mountains of Huanta, in the department of
cucho, a number of sugar haciendas have rece
been started with mechinery brought from
United States, *viâ* the Amazon. The principa
these are named Ayacucho and Vesta Herm
Arguadiente is also made from cane grown in var
other parts of this immense region. The total su
production of the fluvial region does not exc
360,000 kilogrammes. Taking, therefore, the th
divisions of Peru—the coast region, the inte
region, and the fluvial region—it is found that
total production of sugar amounts annually, on
average, to 74,000,000 kilogrammes. The cap
invested in the industry is said to amount
£3,400,000, and the value of the products in 18
the latest year for which the particulars are availa
exceeded £820,000. The amount paid for labour
the same year was £548,000. The total area devo
to the cane industry was 187,000 acres.

HUNGARIAN INDUSTRIES.

In past years different industries attained at vari
times a certain degree of development in Hunga
and some branches, such for example as the ma
facture of gold and silver wares, were in a rema
ably flourishing condition. The making of potte
the tanning industry, and the manufacture of *pas*
menterie also had a certain importance until the e
of the 18th century. The *Revue d'Orient* says th
there are three classes of Hungarian industry,
follows:—The home industry, the small industri
and the chief or more important industries. T
first is engaged in by the rural population, and this
the most ancient. Women work at their homes
making tissues known as *kalotaszeg*, fancy embr
deries, aprons, carpets, fine cloths, and many articl
the colours and designs of which are excelle
Formerly the women only worked for the needs
their families, but as in course of time they fou
that there was a market for the products of th
home industry they applied themselves more en
getically to their work. The attention of the Gover
ment being drawn to this question of home indust
the Ministry of Commerce recognised at on
that it might become a source of great nation
wealth, and was deserving of every encourag
ment. Steps were accordingly taken to organi
this industry, and to preserve in it all its quai
originality and picturesqueness of design, to impro
the methods of manufacture, and to ensure a rea
and remunerative market for the goods themselve
Agents were quickly found, who undertook th

ing upon the markets of the various products, who themselves supplied the raw material. ere are at the present day more than 40,000 sons who derive a regular income from the pro- ts of domestic industry. What are known as the ller industries have been affected by the general of steam and electricity, and the result has been t those engaged in them have turned their atten- to the chief or more important industries, or to t the new requirements, have devoted themselves re to technical instruction, and this is particularly case as regards the lock-making, carpet-making, carpentery industries, all these branches showing best results, which have been, in great measure, to the schools of design and technical instruction anised by the State. It is, however, particularly the chief industries that the progress has been st marked. At first, attention appeared to be ost exclusively devoted to the agricultural pro- ts, and more particularly to flour, which has long oyed a very high reputation, but the importance of ohol, sugar, food products, and chemical products ow recognised, all these articles being turned out a very large scale. There are in Hungary more n 3,500 important factories, the chief of these ng devoted to the metallurgical industry and the lding and machine-making trades. The textile ustry has of late shown a decided improvement e factories in which the business of printing and ing cottons is carried on have long enjoyed a high utation), and there has also been a marked increase he products of the leather industry. Large quan- es of earthen and glass ware are made, and the ber and carriage-making trades send their pro- ts to all markets. The mines and smelting works Hungary date back to a very early period. Before discovery of the gold-fields in the New World, ngary and Transylvania were considered the gold- ring countries *par excellence*, but the latest mining tistics only show a small production of gold and er. The country on the other hand abounds in l and iron, lead, copper, and nickel. The salt duction, which is a monopoly, yields to the hequer, on the average, 15,000,000 florins 1,500,000) annually. The Government encourages every means in its power the introduction of new ustries. Inspectors are appointed to report upon hygienic condition of the factories, and the thods adopted to protect the workpeople against idents. Insurance against accidents and sickness endered compulsory by law, and the authorities, grants and other means, are encouraging the ead of education among the working-classes. In 93, the industrial population of Hungary amounted 299,327 masters, and 719,000 workpeople.

HE POPULATION OF SWITZERLAND.

The population of Switzerland at the last census 88) was 2,917,000, and the average increase of population from 1850–88 was 5·1 per 1,000 inhabitants. The same conditions however appear to exist in that country as in others, namely, that the population of the industrial districts increases, while that of the agricultural districts tends to decrease. According to the Secretary of Legation at Berne, the death-rate averaged 17·6 per 1,000 in the towns in 1894. Influenza was responsible for 2,275 deaths as compared with 2,669 in 1890, and only 268 in 1891. The average of deaths from alcoholism was 6·5 per cent. of the total. In 1888 there were 229,650 foreigners resident in Switzerland, of whom 112,342 were Germans, 13,000 Austrians, 53,000 French, and 41,000 Italians. The English who come into the country, and who do so much to support the hotel industry, would seem therefore to be mostly of the tourist class as there were only 2,577 residents. The emigration of Swiss has diminished from 13,502 in 1883 to 3,849 in 1894, and of these 3,285 went to the United States, of whom 1,273 were agriculturists. These official figures do not include the army of Swiss waiters and hotel servants who go abroad annually for the winter months, to the Riviera or elsewhere, and who return home for the summer tourist season. The average number of suicides per 100,000 inhabitants was 22·5 as compared with 7·5 in England and Wales. A curious coincidence in connection with suicides in Switzerland is that they are about 5 per cent. higher on Tuesdays than on any other day in the week, and for men hanging, and for women drowning, appears to be the method of despatch preferred by each sex.

STOCKHOLM EXHIBITION.

The Stockholm Exhibition of 1897 will comprise engineering, building industry, machinery, implements, transport, shipbuilding and navigation, electricity, fisheries, military science, sport, travelling, fine arts, education and instruction, hygiene, scientific] appliances, &c. The site of the exhibition according to "Kuhlow's German Trade Review," is commodious and picturesque, and will include the Northern Museum and the Bostrom Villa. The exhibition buildings proper are numerous, and the more important are to be, it is said, very striking. The large hall for the industrial section occupies a good position on an elevated terrace, and it is claimed for it that it is one of the largest wooden structures ever built. The building will have a dome 300 feet high, surrounded by four turrets, of which some, if not all, will be fitted with elevators. The view from these points will be a striking one, the environs of Stockholm being of unusual beauty. At each side of the central structure will be a pavilion. To the left of the entrance is the building for the various offices, and those of Norway, Sweden, and Denmark are located there. To the right lies the Northern Museum which is still in course of erection, and where in an auxiliary building the sections for hygiene, education, and engineering will be installed. The machinery hall will be situated at the Saltsjön and will be built of iron and glass alone with an area of about 100,000 square feet. The fisheries exhibition will be located on the borders of the sea, and there will also be found the exhibition of boats, &c. Fishery forms one of the more important industries in Sweden, and this section is to be made large and interesting. The section for forestry will also be comprehensive, as will the agricultural section, the Agricultural Department being much interested in the matter. The art exhibition will in all probability be entirely international. There will be three large halls for Sweden, Norway, and Denmark, and smaller buildings for other countries. The two large universities in Sweden—Lund and Upsala—will also be represented, as will the Medical College, Stockholm.

MINERAL WOOL.

Consul Merritt of Barmen says that of those who know mineral wool, or silicate of cotton, as it is sometimes called, probably only a small number are familiar with the simple process by which it is made. The wool itself, serving a variety of useful purposes, as a non-conducting covering against heat and cold, alike for steam pipes and cold storage-room walls, as a sound-deadener in floors of buildings, and as a means of fireproofing is, as its name implies, a soft and woolly substance, consisting of a mass of very fine mineral fibres interlacing one another in every direction, and thus forming an endless number of minute air cells. The wool appears on the market in a variety of colours, principally white, but often yellow or grey, and occasionally quite dark, and is made by converting scoriæ and certain rocks, while in a molten state, into a fibrous condition by a steam blast directed against the liquid material. Blast furnace slag forms the raw material for one variety of the wool, and sandstone for another, yielding respectively slag wool and rock wool, the latter being preferable for pipe covering, because of the absence of sulphur, which, with moisture present, becomes an active corroding agent. The furnace slag or the rock, as the case may be, is melted in a large cupola, and as it trickles out at the tap hole in a somewhat sluggish stream it meets a high-pressure steam jet, which atomises the woollen material, if it may be so termed, blowing it in fleecy clouds into the storage-room provided for it. Soft and downy, the stuff settles wherever a resting place offers itself, the heavier wool coming down first, while the lighter portions are blown further along by the force of the steam, and settle in the more distant parts of the room. The material thus naturally grades itself into varieties of different qualities. A thousand pounds of wool per hour are turned out by one of the cupolas, and after the storage-room has been blown full, the flocculent mass is pressed into bags, ready for the market. The whole process, says the Consul, affords
an admirable and interesting illustration of the i-
sation of a formerly waste product.

PRODUCTION OF RAW SILK IN RUSS .

The production of raw silk in Transcaucasia du g
the year 1895, especially in the Government of
Kutais, was very unsatisfactory, partly on accou of
drought and heat, which caused an early growt of
the mulberry trees, followed by cold and rain, an n
some places even snow and frost, so that vast qu i-
ties of silkworms perished. Moreover, from 4 o
70 per cent. of the worms perished from the foll -
ing cause. When the silk producers received e
eggs from abroad they were afflicted with the feb ,
consequently the cocoon harvest in Russia was p ,
and the price advanced. Much of the losses e
due to the ignorance of the population concer g
the proper care of the worms. As the Moscow -
dustry requires more raw silk each year, and de s
to be independent of foreign countries, measures e
being taken by the Government and private per s
to teach the proper method of silkworm breed ,
and the production of raw silk. A new soci ,
(called the Society of Silkworm Breeders) has n
organised in the Government of Kutais. In e
Don district many successful trials have been m .
The Government is making every effort to introd e
silk culture into European Russia. In Char ,
bonuses are being given to persons who plant -
berry trees, and preparations are being made for e
organisation of a society for the breeding of s -
worms which, when founded, will be the first of s
kind in European Russia. The production of
silk in Transcaucasia decreased to such an extent t
the supply on Moscow, in 1895, was much less t
in 1894, and the manufacturers, in conseque ,
bought at higher prices.

Notes on Books.

THE INTELLECTUAL RISE IN ELECTRICITY:
HISTORY. By Park Benjamin, Ph.D., LL
London (Longmans).

As the author ends his work with the name
Franklin, it will be seen that he justifies the title
has given to it. It is the result of the labours
many years in the study of a very scarce literatu
and the objects aimed at are thus set forth by
author:—"I have rigidly excluded technicalities a
scientific demonstrations, which, however interesti
to the professional electrician, are as Greek to
general reader; for I address this no more to
wise men of the wires, and the dynamos, and
batteries than to the great public whom we all ser
and for whose good we all labour. Popular scie
so-called is too often dilute science. Scientific d

ions of a didactic or abstract nature, or involving abylonish terminology, and requiring minds ed to understand them, cannot be rendered any r to the mental digestion of intellects engrossed ther departments of the world's work, and hence so educated, by mechanically mixing them with water of an engaging rhetoric. The facts and arguments based on them must be digested and ght into true solution, so that the food offered be easily assimilable, and that is what I have here to do." The history is traced from the y knowledge of amber and the legends connected it, the legends of the lodestone, the astronomy the Chinese, the dark ages and the rise of lasticism to the practical knowledge of the thmen in carrying out their early voyages. The k of Roger Bacon, Peter Peregrinus, Norman, her Paul, Porta, Cardan, and many more of the d of forerunners is then discussed. Dr. William ert's great contributions to the history of science fully considered, and his relations with Bacon ussed. In subsequent chapters the author de- s his attention to the state of physical science in reign of James I., the controversy between lliam Barlowe and Mark Ridley, the founding of Royal Society, the work of Robert Boyle, and vton's reduction of electricity under the reign of . The foundation of the French Royal Academy, the state of electrical progress in Germany are n discussed. The work of Stephen Gray and his overies in electrical conduction and insulation are forth, and these lead up to the last chapter which devoted to the work of Benjamin Franklin, lliam Watson, and others. Then the science had n, and the author leaves his subject, ending with se words:—" When electricity and lightning were wn to be one, the end seemed to have come, and tidings which the amber and the magnet had to were believed of all men to have been told to last syllable. But the book had only been ned. We have read much—very much—from it e. As the rise in ourselves continues, so with al pace shall it be read on." The work is fully strated by portraits and plates copied from old ks; the portrait of Gilbert fills the place of our as the frontispiece.

w's GROCERS' MANUAL: A Practical Guide for ea and Provision Dealers, Italian Warehousemen, handlers, Ship Store Dealers, Bakers, Con- ectioners, Fruiterers, and General Shopkeepers. ompiled and arranged by James T. Law. Liver- ool. 8vo.

his volume of 842 pages contains an account of chief articles of grocery in use, arranged in alpha- ical order, and forms a sort of encyclopedia of one nch of food. In order apparently to break up the icles, so that they shall not be too long, the varie- of certain foods are divided out under special dings; thus, there is a heading of vinegar, but Chili vinegar, malt vinegar, white wine vinegar, and other varieties will be found under their specific names, and olive oil is under olive, not under oil. Much besides food is included in this work, as may be seen by its title, and practical hints on subjects of interest to grocers are given under the various headings. In some cases analyses are added to the articles.

ON SEA AND SHORE: AN OCEAN TRIP TO THE HIGHLANDS. London.

A guide to the Aberdeen Steam Navigation Company's tours from London to Aberdeen by sea, by rail to Ballater, by Canal to Braemar, and then on to Inverness, and back again from Aberdeen. The beautiful scenery of Scotland is well illustrated in this useful little guide.

DIE DECORATIVE KUNST-STICKEREI. I. Aufnäh-Arbeit. II. Leinenstickerei. III. Goldstickerei, von Freida Lipperheide. Berlin.

This is an elaborate work on sewing and art embroidery, and consists of a text in quarto, fully illustrating different kinds of stitches, and an atlas of coloured plates of various specimens of linen and gold and silver embroidery.

General Notes.

PRESENT AND PROSPECTIVE EXHIBITIONS.—According to the *Journal des Tarifs et Traités de Commerce*, the following is a list of the principal Exhibitions open, and of those which will be opened in various parts of the world before the end of the century. 1896:—Industrial and Fine Arts, Odessa; International Pharmaceutical, Prague; International, Cannes; National and Colonial, Rouen; National, Geneva; Industrial, Berlin; Maritime and Fisheries, Kiel; International, Mexico; Exhibition at Para; Exhibition at Johannesburg; Provincial, Namur; Colonial, Paris; Electric, New York; Industrial Arts, Barcelona; Departmental, Nantes; Local, Pau; International Mining and Industrial, Denver (Colorado); Agricultural Machinery, Vienna; National, Nijni-Novgorod; Hygienic, Innsbruck; Exhibition of Natural Hygiene, Lyons; Motors and Automatic Carriages, London; International Exhibition of Sporting Arms and Articles for Hunting and Fishing, St. Petersburg; International Theatrical and Musical, Paris. 1897:—International, Brussels; International Horticultural, Hamburg; Rio Janeiro Exhibition; Central American, Guatemala; Exhibition at Brisbane; Exhibition at Stockholm; International Montreal; International Industrial and Fine Arts, Nashville (Tennessee). 1898:—Universal, Amsterdam; Exhibition at St. Paul, Brazil; Exhibition at Turin. 1899:—Exhibition at Adelaide. 1900:—Universal Exhibition at Paris.

SOUTH AFRICAN TRADE.—According to the last report of the Durban Chamber of Commerce it appears that the imports into Natal in 1895 were valued at £2,469,000, as compared with £2,316,000 in 1894; the imports into the Cape amounted to £13,612,000 (£11,298,000 in 1894), and into the Transvaal, £9,816,000 (£6,440,000 in 1894). The exports were as follows, the figures for 1894 being stated in brackets:—Natal, £1,318,000 (£1,197,000); Cape Colony, £16,798,000 (£13,696,000). There are no statistics of exports from the Transvaal, these are included with those of the Cape Colony and Natal. From the above figures it will be seen that while during the period referred to the imports into the Transvaal increased in value by upwards of £3,000,000 sterling, the imports into Natal show only a nominal increase. The four principal ports of the British Colonial possessions in South Africa are East London, Port Elizabeth, and Cape Town in Cape Colony, and Durban in Natal. Of these the most important is Port Elizabeth, the value of the imports in 1895 having amounted to £6,879,000 as compared with £5,409,000 in 1894. Cape Town ranks next in importance, the imports for 1895 being valued at £3,536,000 (£3,258,000 in 1894). East London, in 1895, imported to the value of £2,932,000 (£2,373,000 in 1894), and Durban, in 1895, £2,469,000 (£2,317,000 in 1894).

THE PAPER INDUSTRY IN FINLAND.—The first paper machine in Finland was established in 1842 at Tammerfors, although it is stated by Herr Björkenheim, in the *Papier Zeitung*, that there were one or two paper manufactories in Finland during the 16th and 17th centuries. Until 1860, the home production was insufficient for consumption, but the employment of chemical and mechanical pulp beginning to extend, paper making made great progress, and is now one of the most important industries of the country. In Finland, there are 13 paper mills, 7 chemical pulp factories, 3 straw pulp, and 20 wood pulp and pasteboard factories. The number of workmen employed in these different factories amounted to 3,847 in 1894. In 1893 the production amounted to 32,000 metric tons of mechanical wood pulp, 8,000 of chemical, and 7,500 of paper. The factories chiefly employ English machines, but recently German and Swiss makers have received orders. The total number of paper machines in Finland is 26. Two mills only make rag paper; two mix rags with first-class paper; three add straw pulp; and all the others make wood paper exclusively, and at need employ chemical pulp. The rags are imported from Russia, the total imports being 1,220 metric tons in 1891, 867 in 1892, and 727 in 1893.

THE TRADE OF SAMOA.—A correspondent of the *Economiste Français*, in a recent communication to that publication, says that the trade of Samoa, particularly with Europe, is showing signs of rapid development. Increased trade is also being carried on with New Zealand, the United States, and Tonga. From 1890 to 1894 the value of the trade ha creased from £64,000 to £154,000. Imports gr exceed the exports (the former amounting, in 1 to £90,000 as compared with £43,000 in 18 English, German, and American goods are the la in demand, the first amounting in value to £56, From 1890 to 1894 these imports have increas the following proportions, English 50 per ce German 12 per cent., and American 8 per c Among imported articles the principal are toba hunting guns, powder, beer, spirits, and wine. exports attained a value of £64,000 in 1864, as c pared with £21,000 in 1890. From 1893 to 1 the value of the exports increased by £17,000, sum representing more than four-fifths of the t export trade five years before. Copra is the princ product of the Samoan Islands, the quantity of article exported in 1894 exceeding by 1,600 tons of the previous year. The total export of co amounted to 6,536 tons against 4,872 tons in 18 After copra comes cotton and coffee, but th articles are decreasing in importance. The fore population in Samoa was composed as follows 1894—26 French, 193 English, 122 German, American, and 25 persons of other nationalities.

MUSHROOM GROWING IN GERMANY.—An exp ment to transplant to Germany the growing of mu rooms has been made in Wiesbaden after the meth of the Paris catacombs. A large cellar under ext sive storage rooms was fitted out for the purpo The cellar is 500 square mètres, and contains th times 400 square mètres of surface for beds, as th wooden frames with bed surface have been placed over the other. The temperature is kept as u formly as possible at about 66° Fahrenheit, duri summer and winter. The process of growing is follows:—The prepared horse manure which has ferment is packed into the beds on wood frames the cellar, then the mushroom spore is embedded in the horse manure, and is left untouched for thr weeks until the seedlings appear to view. Then layer of earth is placed over them and the entire ma is kept damp by watering, and after a fortnight t picking can begin. Through a varying course of pr cedure the daily picking amounts to about twen five pounds. Whether the quality of these mus rooms comes up to the standard of the French is, is stated, not yet known.

ITALIAN EMIGRATION.—According to a note "L' Italia Agricola" a statement has been pu lished by the Italian Ministry of Agriculture concer ing emigration from Italy in 1895 as compared wi 1894. In 1895 the number of emigrants, as indicat by the passports issued, was 293,181 of every age an sex—of whom 169,513 were permanent and 123,6 temporary emigrants. In 1894 the total number w 225,323, namely, 105,455 permanent and 119,8 temporary. Of the 293,181 Italians who emigrat in 1895, 113,682 went to America, chiefly to Arge tina, Uruguay, Brazil, and the United States.

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1897.

The dates fixed for the Society's Examinations 1897 are Monday, March 22nd, Tuesday, rd, Wednesday, 24th, and Thursday, 25th.

The Programme of Examinations is now ady. Copies of the Programme, with full tails, and an Appendix containing last ar's questions and reports by the Examiners, n be had, price 3d., post-free, on applica- n to the Secretary, Sir Henry Trueman ood, Society of Arts, Adelphi, London, W.C.

roceedings of the Society.

CANTOR LECTURES.

PRECIOUS STONES.

Prof. Henry A. Miers, M.A., F.R.S.

Lecture I.—Delivered April 13, 1896.

The object which I have proposed to myself these two lectures is to consider, not the story nor the artistic interest of precious nes, but simply some of their curious operties. In the first place, then, I will k you to accompany me in the inquiry as to ose characters of precious stones to which ey owe their beauty and their value, and xt to pursue the inquiry a little farther, and see how, by means of these characters, the me stones may be studied, and hence, also, ntified with accuracy.

From the earliest times certain minerals, ich are conspicuous for their beauty, have en prized for decorative purposes: the lliant green hue of malachite, the deep e of lapis lazuli, and the rich colour of red per would naturally attract early attention. But these particular minerals are not numbered among the true precious stones; they do not possess the remarkable qualities which endow the diamond, the ruby, or the topaz with their peculiar attractiveness. The two essential qualities, namely, brilliancy and hardness, are only possessed by certain rare minerals; a brilliancy which makes them unrivalled for ornamental purposes, and a hardness which protects them from wear and tear, and makes them practically indestructible.

It is difficult, in a town like London, where every jeweller's shop is ablaze with diamonds, to realise that large and good stones possessing these qualities are so rare; that thousands of natives are toiling in the river beds of India, Burmah and Ceylon, washing out from the gravel or the sand the little blue and red pebbles which are to be converted by the lapidary's art into brilliant jewels of sapphire and ruby. Even in that wonderful pit at Kimberley, where half the diamonds of the world seem to have been crowded together for the use of man, although, perhaps, ten tons of diamonds, worth more than £50,000,000, have been extracted in 25 years, yet those which weigh more than an ounce each may be counted on the fingers.

It is in the qualities of hardness and brilliancy that such minerals as malachite and lapis lazuli fail; owing to their comparative softness, they would not, if cut and polished, possess the sharp edges and brilliant surface of the emerald or sapphire, and would soon become dull and rounded by friction, even by the friction of ordinary dust. Again, since they are opaque, they can never flash like the sapphire or the emerald; and yet it is quite a mistake to suppose that the necessary qualities are confined to those few stones which are familiar to everyone, such as the diamond, ruby, sapphire, emerald, garnet and amethyst. There are many others though they are not so well known. I think we may fairly assert that such minerals as tourmaline, jargoon, peridote, spinel and chrysoberyl, though their names may be familiar, are not stones which would be recognised by any but those who are in some sense experts; while other minerals, such as sphene, andalusite, axinite, idocrase, and diopside are possibly almost unknown to most people even by reputation. Yet all these minerals possess qualities of transparency, hardness, and beauty of colour which render them extraordinarily interesting and attractive as precious stones. (A number of facetted stones cut from the less known minerals were thrown upon the screen by reflected light.)

Take first the hardness. A few years ago, the hardness of stones was a very important character in the eyes of the mineralogist; it was one of the characters by which they were invariably identified, and a distinguished German mineralogist drew up a table by means of which the hardness of minerals can be compared. Any stone is said to be harder than the minerals of this scale which it can scratch, and softer than those by which it can be scratched. In the right hand column the gem-stones are arranged according to their hardness.

MOHS' SCALE OF HARDNESS.

1. Talc.	
2. Gypsum.	
3. Calcite.	
4. Fluor.	
5. Apatite	Sphene. Opal.
6. Felspar	Diopside. Moonstone.
	Epidote. Idocrase. Peridote. Axinite.
7. Quartz	Quartz. Tourmaline. Cordierite. Garnet.
	Andalusite. Zircon. Emerald. Phenacite.
8. Topaz	Spinel. Topaz. Chrysoberyl.
9. Corundum	Ruby. Sapphire.
10. Diamond	Diamond.

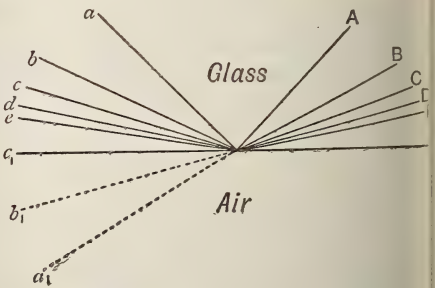
Among precious stones diamond stands out pre-eminent as the hardest of all known substances. Ruby and sapphire are scratched by diamond alone, while chrysoberyl, topaz, and spinel scratch all the remaining stones, although they do themselves yield to the scratch of ruby and sapphire. The hardness is a character still generally utilised by the expert when he is in doubt; in experienced hands it has some value. By long practice it is possible to form a very close estimate of the hardness of a given stone, and that often, not by the scratch of the other minerals in the scale, but by the feel of the stone against a file; the resistance offered by the stone to the file is taken as a measure of its hardness. It is not a character capable of any accurate measurement, neither is it to be recommended for use by inexperienced
persons. I hope to show, as I go on, t
we have now accurate methods of testing
our disposal which render the trial of hardn
quite unnecessary. But, none the less,
character is one of great importance, as
vesting the stone with durability; all
precious stones, except moonstone, opal a
sphene, have at least the hardness of quar
and can barely be scratched by metals, ev
by hard steel.

Take, next, the quality of brilliancy. T
depends upon two things—firstly, the man
in which rays of light are affected when th
enter or leave the stone, and, secondly,
manner in which this action can be inten
fied by the art of the lapidary.

When light passes from one transpar
substance to another it is bent or refracted,
every one knows from the bent appearance
a stick plunged into water. Consider, now
ray of light falling upon the surface of a tra
parent stone; a portion of the light is reflect
but a portion enters the stone. In passi
from air into the stone, it is refracted inwar
When, on the other hand, it passes from
transparent stone into air, its course
reversed, and the emerging ray is refract
outwards or towards the surface. It is, ho
ever, with the emerging as with the enteri
light—the beam is sub-divided, only a porti
is refracted out, another portion of the lig
is reflected within the stone.

Consider, next, successive rays within
piece of glass or a stone which are ab
to emerge with different inclinations. (S
Fig. 1). As their course approaches mo

FIG. 1.



TOTAL REFLECTION OF LIGHT IN GLASS.

nearly to the surface, so will the emergi
rays issue more nearly along the surface
the stone; but the obliquity of the emergi
rays increases much more rapidly than th
of the internal rays, until for one ray in t
series the direction of the light (C in t
Fig.), refracted out actually coincides wi

at surface. What, then, will happen to e light within the stone, which falls still ore obliquely? It cannot be refracted t, and, as a fact, is entirely reflected ithin the stone. Imagine, then, how much reater is the brilliancy of the beam of light, *e*, *d*, which is completely reflected, than that f the intermediate portion of the reflected ght, *a*, *b*, *c*, which has lost a large part of its ys by refraction. The difference is easily en by looking at a glass of water held above e head; the brilliant silvery appearance f the surface, when viewed obliquely, is due total reflection. The light, *c*, *d*, *e*, is said have been totally reflected; and half the ngle between C and *c* is called the "angle of tal reflection." This angle depends upon e refractive power of the stone. The angle f total reflection for diamond is about 25°; in o other stone is the corresponding angle less an 30°; for most of them it is much greater; hile for heavy glass it is about 40°. Light, riking the internal surface more obliquely is flected, without losing any of its rays by fraction.

It is very clear, then, that of the light avelling in different directions within a iamond, a far larger proportion is internally flected than is the case with any other stone. Ve shall see presently that it is this property hich gives the diamond its consummate rilliancy.

Another effect produced by refraction is, as very one knows, the separation of ordinary ght into rays of different colours—it is seen in ny prism of glass. This property is known as e "dispersion" of light; and a stone which ossesses great dispersion will exhibit a beauti-l play of spectral colours—will exhibit a high egree of what is called fire. In this respect gain the diamond is pre-eminent; its disper-on is nearly twice as great as that of other ones.

All these optical properties are beautifully own by those unworked jewels of which the nooth facets have been produced by nature; mean the crystals of the various minerals. he beauty of natural crystals of transparent inerals is largely due to the optical effects hich I have just been describing.

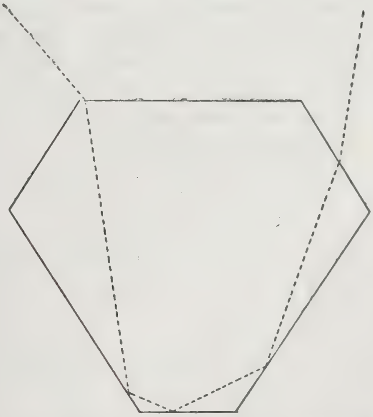
The beautiful specimens of rock crystal, lc spar, topaz, emerald, and other stones hich adorn mineral collections are sufficient idence of these properties. But it is very rtain that natural crystals, although they ossess a beauty of form which is all their own, e not by a long way so brilliant as the facetted stones which are cut from them by the art of the lapidary; that a natural diamond is not so lustrous as a facetted brilliant.

In fact, many of the finest gem stones present a very mean and sordid aspect before they have passed through the hands of the lapidary; one has only to compare the dull and unattractive appearance of a parcel of rough rubies, sapphires or diamonds, with the finished jewels displayed in the jewellers' windows to see how much these owe to the lapidary's art.

In re-cutting the Koh-i-nor it was thought advisable to spend £8,000 on the process and to reduce its weight from 186 to 106 carats. When the great Pitt diamond was cut its weight was reduced from 410 carats to 137; and the fragments and dust removed were valued at £8,000; but the extent to which the stone was improved is indicated in the fact that having been purchased for £20,000, it was after cutting sold for £135,000.

To understand how the cutting of a precious stone adds to its brilliancy, we have only to trace the course of the rays within the stone, and consider how it can best be facetted in order that the light which enters in various directions on the upper side, or crown, may be reflected internally from facet to facet on the under side of the stone with as little loss as possible, and may be finally thrown out from the front of the stone. For this purpose the facets must be so arranged that as much of the light as possible within the crystal shall meet the facets at an inclination exceeding the angle of total reflection. A brilliant with its 58 facets is one of the forms which experience has shown

Fig. 2.



Total Reflection of Light within a Brilliant.

to be best adapted for the purpose. How little of the light gets through a stone so facetted, and, therefore, how much of it is totally reflected internally, is easily shown by holding the stone in a strong beam of light; first so that the light is reflected, and then so that the light shall, if possible, be transmitted. In the latter case, the stone merely throws a dark shadow, indicating that little light, if any, has passed through it.

A facetted stone is always cut from a single crystal, and not from an ordinary lump of the mineral, which is generally a mass of crystals. The chief reason why jewels are cut from natural crystals is that these, by virtue of their crystalline nature, are remarkably homogeneous, and therefore clear and limpid when free from cracks and flaws. A stone which is not homogeneous can never have the purity and limpid brilliancy of a single crystal, for at every point of contact of one part with another reflexion takes place. Among minerals used as precious stones which are not crystals, may be mentioned the opal. The opal probably owes its peculiar beauty to the very fact that it is filled with minute cracks or cavities, each of which contributes some tint of colour by reason of its extreme thinness, just as the colours of a soap-bubble are due to the thinness of its film.

Or take the agate. Here the stone consists of layers of different materials differently coloured. Its beauty is of a totally different nature from that of clear crystals, which it can never rival in brilliancy. Stones like the agate are generally classed apart as semi-precious stones, and their interest depends upon beauty of structure or colour, or possibly to a large extent upon their rarity. The turquoise, for example, is a very rare stone, which is apparently absolutely uncrystallised, but possesses great beauty of colour, and is therefore much prized. The same is true of carnelian. On the present occasion we are not concerned with those opaque or curiously structured minerals whose beauty resides almost solely in their colour.

Those who have had no practical acquaintance with minerals, have little idea how variable and accidental are their colours. They may scarcely realise that the ruby and the sapphire are the same mineral, and that this mineral also occurs, and is used in jewellery, absolutely colourless when it is known as lux sapphire, green as the so-called Oriental emerald, and yellow as the so-called Oriental topaz; that topaz itself may be yellow, brown, blue, or colourless; that zircons range fro colourless through almost all conceivab shades of brown and green, and that eve diamond has been found green, red an blue.

When we come to consider the properties b which precious stones are recognised, I sha say little or nothing about colour, for it is little value as a criterion. There are, f example, certain red stones which the mo skilful experts cannot by their colour alon refer with certainty to ruby, garnet or spine It might be expected that a noteworthy diffe ence in chemical composition would accom pany this difference of colour, or that the pig ment could be ascertained by analysis. I reality, this is scarcely ever the case. It i fairly certain that the emerald owes its colou to the presence of chromium, but the variatio in the analyses of precious stones canno generally be attributed to anything indicate by the variation of colour.

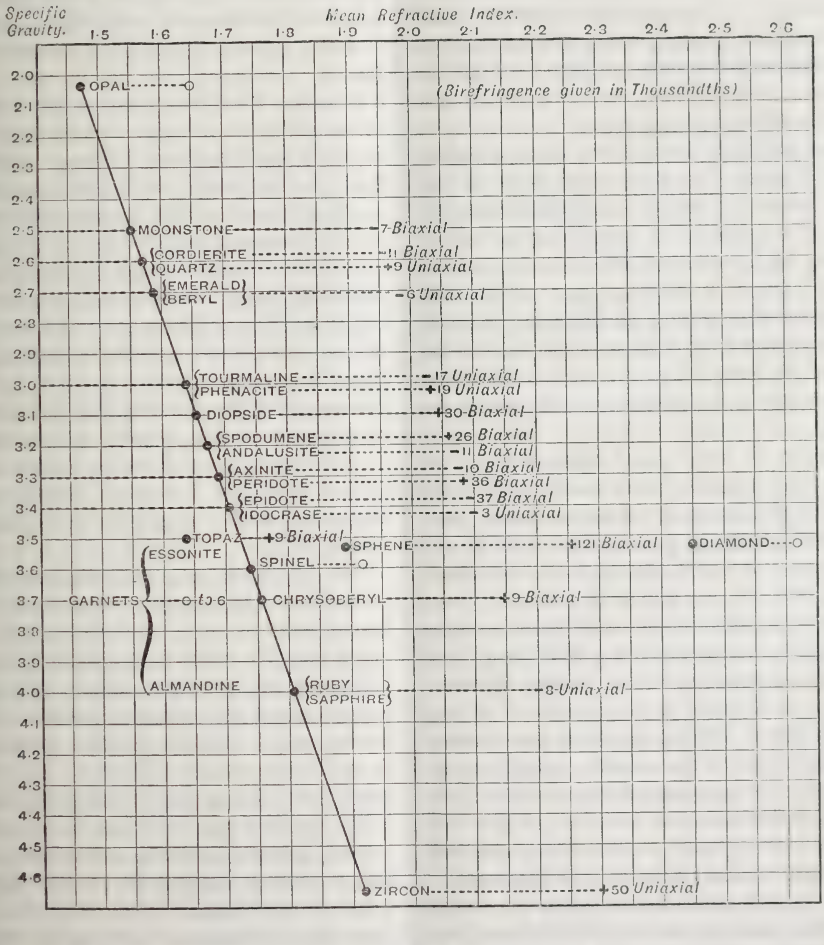
The chemical composition, though of grea general importance in mineralogy, is of littl practical value in the discrimination of preciou stones, since it is usually impossible to sacri fice a sufficient quantity for chemical analysis If we are dealing with a facetted stone, no even the smallest portion can be utilised, fo fear of injuring it.

There is, however, one remarkable optica property, which is ultimately related to th chemical composition. As is well known many substances possess the property o absorbing certain rays of light. When th solar spectrum produced by admitting ordi nary daylight through a slit, and transmitting it through a prism, is passed through th glowing vapour of certain substances, par ticular rays of light are absorbed, and thei absence from the emerging light is manifeste by corresponding dark bands in the spectrum The instrument by which the observations ar made is the spectroscope. It is well known t most people that the solar spectrum itself con tains certain dark bands of this sort, which are produced by vapours that can be identifie by the position of the bands in the spectrum; and thus it is possible to ascertain something regarding the chemical constitution of the sun and certain of the heavenly bodies. Now, a precisely similar effect is produced by certain elements if present in a mineral, by merely transmitting the light through a piece of it. Thus, transparent minerals which contain the rare element didymium, betray the presence of that element as soon as they are viewed through spectroscope by ordinary daylight; the spec-um is seen to be traversed by black bands in he green, which are quite characteristic.

Among gem stones there are two which ossess this curious property. One is the variety f red garnet, known as almadine, and the ther is the jargoon. The almandine produces haracteristic bands in the green, and the argoon in the red, green and blue portion of he spectrum. To see these remarkable bsorption spectra, to which attention was first alled, I think, by my friend, Professor Church, t is not necessary to look through the stone, t is quite sufficient to place it in a strong ight, and look at it through an ordinary ocket spectroscope; the light which enters he instrument consists largely of rays which ave penetrated the stone, and been reflected rom the facets at the back. These rays produce the absorption spectrum. In this way we are enabled to identify a jargoon or an almandine merely by looking at it. There is no test so simple or so easy of application. It is curious that the almandine, or iron-aluminium garnet, is the only garnet which presents an absorptive spectrum, and it is not yet certain to what element the bands are due. In the case of jargoon, they are supposed to be caused by the presence of some uranium compound in the mineral. All the almandine garnets which I have examined, and nearly all the jargoons, show these characteristic absorption spectra.

By way of summary, I have thought it desirable to indicate the general characters of precious stones in a diagram, which exhibits some of their relationships and also some of their differences in a graphic manner.

FIG. 3.



Opal, which is a comparatively light mineral, has a low refractive power; zircon or jargoon is a heavy mineral, and has a high refractive power. Let now the refractive power of any mineral (as measured by its refractive index for yellow light) be represented by a corresponding length set off from left to right, and let its density (as measured by its specific gravity) be represented by a corresponding length measured downwards. Fixing in this way a point corresponding to opal, and another representing the character of zircon, draw a straight line from the one to the other. It will then be found that the points which, by their position on the diagram, represent the specific gravity and refractive index of the various minerals, will be very nearly upon this line; that is to say, as the refractive index of precious stones increases, so also does their density, and the two increase together in a remarkably regular manner.

It appears from this table that those minerals which, by their high refractive power, possess the greatest brilliancy, possess also the highest specific gravity or weightiness; that the precious stones are therefore all heavy minerals. There is also a rough general correspondence between these characters and the hardness of the stones; the brilliant heavy minerals are also generally speaking hard.

Two remarkable exceptions display themselves. Sphene lies far to the right of the position which it should occupy according to its specific gravity; it possesses an extraordinarily high refractive index, and is, therefore, an extremely brilliant gem stone. On the other hand, a glance at the scale of hardness shows that it is, unfortunately, one of the softest of the possible gem stones, and that in this respect it is not very well fitted for jewellery.

Diamond is still more remarkable; its refractive index places it at the extreme right of the diagram, with a refractive power, and therefore a brilliancy, greater than that of any other stone; at the same time its hardness exceeds that of any mineral, and this combination of qualities renders it the chief among gem stones, unequalled for brilliancy and durability, although not a heavy mineral. Moreover in dispersion, and therefore in fire, it stands alone. Minerals which are heavier than zircon, such as the metallic sulphides and iron-glance, are unsuitable for gem stones since they are nearly opaque, but they follow the same law, and possess a refractive power still greater than that of zircon or even diamond.

There is one other stone which is exceptional but in less degree and in the other direction, namely, topaz, whose refractive index is not 1·7, as it should be by its position on the line due to the specific gravity, but 1·62; t point corresponding to topaz must therefc be placed a short distance to the left of t line. It is curious that these three exceptior stones lie on the same horizontal line, havi all the same specific gravity, 3·5.

In mentioning the specific gravity I have i troduced a property which is not essential win esteem for a precious stone, but one whi is of great value in its identification.

We have next then to consider those pr perties by which precious stones may in pra tice be most readily recognised. The tab shows very clearly that specific gravity is o such property. The meaning of speci gravity is easily explained. A piece of tou maline of any size weighs three times as mu as an equal volume of pure water at 4° C., t specific gravity of tourmaline is therefore sa to be 3; a piece of almandine garnet of a size weighs four times as much as an equ volume of water under the same condition and the specific gravity of garnet is ther fore 4.

Now any substance immersed in water los in weight by an amount exactly equal to th of the water displaced. Hence to ascerta the specific gravity it is only necessary suspend the stone by a fine thread to the bea of a balance and weigh it first in air, and the immersed in water. The first weighing giv the weight of the stone itself, the difference b tween the first weighing and the second giv the weight of the displaced water; hence t specific gravity is found at once by dividin the weight of the stone by this difference. F very small stones, where the weights co cerned are slight, it is necessary to use refined chemical balance. But for ordina stones a well made Westphal balance i sufficient.

The Westphal balance is constructed on th principle of the common steel yard. At on end of the beam is a counterweight, at th other end the stone is suspended; the bea is divided into ten equal parts. A weight ca be suspended on the beam, and its action, c course, varies with its position on the beam at the tenth division from the centre it has value ten times as great as at thefirst division

The specific gravity is then found as follows —First, counterpoise the counterweight. Le this require a weight, A, on the right han side of the beam. Next, find the weigh necessary to restore equilibrium when th stone is suspended from the beam. Let thi be B. Then A — B is the weight of the ston ir. Next, raise the vessel of distilled er below the stone until it is immersed. If e the weight now required to restore equi- um, C − B is the loss of weight in water, , finally, the specific gravity is $\frac{A - B.}{C - B.}$

his process is known as "hydrostatic ghing," and can be applied to any stone, ept such as are very small. Great pre- tions must be taken, in order to determine specific gravity with accuracy. Especially it necessary to free the stone from all ering bubbles of air. For this reason the cess of hydrostatic weighing is a somewhat orious one.

ow, in order to identify a mineral, it ought be unnecessary to determine exactly the cific gravity, provided that means can be ised for showing that its specific gravity is same as that of some known substance. purposes of identification, a comparative thod is often quite as efficacious, and much re easy than actual measurement. This y now be done by means of certain heavy ids.

Vood floats in water because it is lighter n water; iron sinks because it is heavier; a substance which possessed exactly the cific gravity of water would neither float sink, but would remain suspended in the ter like a balloon in mid air. Take, then, a iid which is heavy—the most convenient is thylene iodide, whose specific gravity is 3·3 fragment of zircon will sink in this, and a gment of tourmaline will float, but a fragment he mineral augite, whose specific gravity is o 3·3, will exactly remain suspended.

This liquid, then, enables one to say with tainty whether a given stone has a specfic vity greater or less than 3·3; in the one e it will sink, in the other it will float.

But methylene iodide further possesses the uable property of mixing easily with ben- ie, which is a very light liquid. Every drop benzene added reduces the specific gravity the mixture, which can thus easily be made range between that of chrysolite and that of al.

To identify any one of the stones which lie ween those limits on the diagram, it is only essary to drop it into a test tube or small sel containing methylene iodide—the stone l float—benzene is added drop by drop, the xture being kept well stirred until a point is ched at which the stone neither sinks nor ats. Then different fragments of mineral possessing specific gravities between 3·3 and 2·5 are taken in order of increasing density and dropped into the liquid; the stone under examination possesses a specific gravity between that of the last which floated, and the first which sinks, and the limits may, if necessary, be further narrowed by comparing it with other mineral fragments of known density intermediate between those two. One great advantage of this method is that the size of the fragment does not affect the result; a minute fragment only just large enough to be visible is equally convenient; in fact, is more convenient than a larger one.

If a stone in the rough is under examination, a minute chip can easily be taken from it, and used for the experiment in the most satisfactory manner. The method is moreover extremely sensitive; a mere drop of benzene added to a considerable volume of the liquid is sufficient to send to the bottom a stone which was previously floating.

So much for stones whose density is less than that of chrysolite. As regards the denser minerals, it was until a short time back impossible to test them by any such method; they all sank in the heaviest liquid available. But now, thanks to the fortunate discovery by Dr. Retgers of the remarkable properties of thallium-silver nitrate, all the known gem stones may be distinguished by a similar process.

This salt, which may be prepared by fusing together in equal molecular proportions nitrate of silver and nitrate of thallium, possesses the remarkable property of fusing at a temperature far below that of either of its constituents, and well below that of boiling water, while at the same time the fused salt possesses a specific gravity greater than that of zircon. The salt fuses at 75° C. to a clear colourless liquid in which zircon just floats; it further possesses the useful property of being miscible in all proportions with water, so that the specific gravity can be reduced to any desired extent by adding water, just as that of methylene iodide was reduced by adding benzene. The substance can be kept liquid by maintaining it at a temperature above 75° C., and this may easily be done by immersing the vessel in which it is contained in water heated to near the boiling point.

In these two liquids then we have the means of producing a liquid of any required density for the discrimination of gem-stones, since we can obtain from one or the other a liquid in which any precious stone will be exactly suspended.

The nitrate might be used by itself to include the whole series, but it is more convenient to use the methylene iodide when possible, both because it can be employed at ordinary temperatures and because it is cheaper than the nitrate.

Both substances darken on exposure to light, and should be both kept and used in the dark as far as possible; they are easily freed from the liquid employed to dilute them. The benzene readily evaporates spontaneously from the methylene iodide, and the water can be driven off from the diluted thallium-silver nitrate by boiling.

Miscellaneous.

PRIZES OFFERED BY THE SOCIÉTÉ D'ENCOURAGEMENT.

The French Société d'Encouragement pour l'Industrie Nationale was founded at the beginning of the present century, on the initiative of Benjamin Delessert, for welcoming all useful discoveries, rewarding the efforts of inventors, and recommending the application of their labours to those engaged in the industrial arts. The object pursued by the society is, in fact, a close alliance between practice and theory, which are now, observed J. B. Dumas, inseparable. The prizes, whose value exceeds 100,000 francs (£40,000), awarded every year are arranged so as to recompense alike the discoveries proceeding from the laboratory or study of the savant and the inventions originating in the workshop.

A large gold medal is awarded annually to the inventors, in France or other countries, whose labours have exerted the greatest influence on the progress of French industry during the previous six years, the English recipients having been Sir Charles Wheatstone, in 1873, for physics and the economical arts; Mr. Walter Weldon, in 1880, for architecture and the fine arts; and Lord Kelvin, in 1894, for the economical arts.

The sum of 40,000 francs (£1,600) was left to the society for founding a prize of 1,200 francs (£480), to be awarded every six years, to the inventor of the improvement most useful to French industry, especially as regards articles in which France may be behind other nations, as regards either the quality or the cost of production. This prize will be next awarded in 1898, if there be ground for it. Alternately with the above, the Société d'Encouragement awards, every six years, a prize of equal value for the discovery most useful to French industry, and this prize was awarded in 1873 to M. Pasteur, and last year to M. Lippmann, for his discovery of chromophotography.

The exhibitors in class 27 of the Paris 1867 Exhibition subscribed a sum of 13,170 francs (£52 founding a prize, to be awarded every six years t most effective contributor to the developmen progress of the cotton industry in France. Tho class 47 of the 1878 Paris Exhibition founde annual prize of 1,000 francs (£40) for the work who has spent the largest number of years con tively in the same establishment. The exhibito class 50 of the Paris 1889 Exhibition have lo with the society the sum of 9,846 francs 75 cent (£393 11s. 5½d.) for founding a triennial prize of 1 francs (£40) for rewarding scientific or technical in tigations calculated to improve the plant or met of agricultural works and alimentary industries.

To perpetuate the memory of the Belgian sav Melsens, his widow has handed over to the so the sum of 5,000 francs (£200) for foundin triennial prize of 500 francs (£20), to be awarde the inventor of an application of physics or chemi to electricity, balistics, or hygiene.

The following are some of the special prizes, al 2,000 francs (£80), to be awarded by the Soc d'Encouragement during the next few years. In 1 for an application to grinding grain of methods gi better results than those at present employed; in 1 for a motor weighing less than 50 kilogrammes (110 l per brake horse-power; in 1897, for a small mo intended for executing work at home, either i pendently or connected with a central power stati in 1897, for utilising the residue of manufacture 1898, for an experimental study of the physical mechanical properties of one or more metals or al of current use; in 1899, the discovery of a new a useful in the arts; in 1899, for a study of the ex sion, elasticity, and tenacity of ceramic pastes; 1897, for a scientific study of the physical mechanical properties of glass; in 1899, for the covery of processes capable of furnishing us organic matters, such as quinine and cane sugar; 1899, for the scientific study of an industrial pro the theory of which is still imperfectly known; 1898, for the invention of new methods permittin utilising petroleum, advantageously and with danger, in industry or domestic economy; in 1 for a hydro-extractor or centrifugal machine of c tinuous effect.

Prizes, each of 3,000 francs (£120), and both be awarded in 1897, are offered by the society fo improved manufacture of permanent magnets, also for the production of photo-engravings for ty graphy; while the Société des Ciments Français Boulogne-sur-Mer, offers a prize of 1,000 fra (£40) for the best description of a practical meth not chemical, and applicable in works, for detect the adulteration of artificial Portland cement.

Competitors for the prizes may be of any nati ality, but the descriptions, &c., must be written French, and sent before the 31st December of year preceding that in which the prize will awarded, to the secretary of the society, 44, Rue Rennes, Paris.

THE INDIA-RUBBER INDUSTRY.

ie United States Consul at Barmen, in a recent
rt to his Government, says that the world's con-
ption of india-rubber has been growing so enor-
sly during the past few years, that the time does
seem to be far distant when the demand will
tly exceed the supply. Already the difficulty of
ng a sufficient quantity of rubber to meet the
ent needs, has led consumers to fear that there
be an early famine. One of the chief causes of
heavy increase in consumption is of course the
loyment of the material in the bicycle trade, and
before the limit has been reached in this direc-
, another field is being opened up in the use of
imatic tyres upon vehicles of all descriptions.
United States is one of the largest consumers of
a-rubber at the present time, but that country is
owed pretty closely by Great Britain. The other
kets follow a long way behind, but the quantity
orted by France and Germany is a no mean pro-
ion of the trade done in this material. It is
ain that the threatened famine in india-rubber—
more properly speaking, caoutchouc—would not
o imminent as it is, if the owners of the planta-
s in West Africa and elsewhere had been a little
reckless in their methods of tapping the trees.
rder to more easily get at the milky juice, it has
been the custom in West Africa, and in some of
South American States, to cut down the trees
ily, so that the collectors secured only one lot of
caoutchouc from each tree instead of a large
nber of periodical yields. The prevalent idea that
policy was justified by the almost unlimited range
orests producing caoutchouc, was very soon found
e groundless, and stringent regulations have been
le to prevent the cutting down of the trees in many
ntries, and owners are going to a great deal of ex-
se in laying out new plantations, which must take
eral years to come to maturity. In the meantime
rts are being made to compensate for these limited
plies by producing artificial india-rubber, and
eral new processes have lately been bronght out
France and Germany, though without as yet pro-
ing india-rubber of a suitable quality upon a com-
rcial scale. The most obvious way of meeting the
nand for this material is to give more attention to
ne of the other rubber-producing trees that are to
found in considerable quantities in South America
l elsewhere. At the present time French capitalists
trying to make profit out of the scarcity of india-
ber by utilising the balata, which, for many years,
been employed upon a small scale for a variety of
poses. There are at least two descriptions of
ata, one white and one red, the latter being known
he "bullet-tree." The species being exploited in
nch Guiana is the *Mimusops balata*, a magnificent
which is peculiar to all the Guianas. It attains
eight of from 90 to 100 feet. The wood is very
ch sought after for cabinet making, on account of
beautiful colour, while it has also the property of
resisting the depreciation of insects. These merits are almost fatal to the existence of the tree as a rubber producer, and in some of the South American States, forests are being cut down without any regard to the profit that can be secured by tapping them in an intelligent manner. In Venezuela the tree is also to be found in great abundance, and it grows very freely in the mountainous districts of the northern states of South America. In British Guiana immense forests are found in the low-lying districts of swampy Canje. In a report on the balatas, published recently by M. Hayes, a colonising agent, it was said that there was a sufficient expanse of forest in the Guianas to allow of the exploitation of rubber being carried on for centuries. It was, however, necessary that something should be done to prevent the wholesale destruction of the *Mimusops balata*, which would very soon disappear, if allowed to be cut down indiscriminately for its wood, and one of the richest and most prolific resources of South America would thus be destroyed. In fact, both in Venezuela and the Dutch Guiana the trees are cut down with a view to collecting as much of the juice as possible, and in French Guiana the same process was for a long time employed. When the trees are thus felled, circular cuts are made every 12 inches, and receptacles are placed underneath to catch the juice. The bark is also removed from the tree and juice extracted from it by presses. In British Guiana it is only permissible to tap the trees without felling them, and a similar restriction is now imposed in the neighbouring French colony. The English method of collecting the rubber is to make horizontal incisions halfway round the tree, and connect them with a vertical channel to allow of the fluid flowing down into the receptacle, but a better method is said to consist in cutting out rectangular pieces of bark from which the juice is extracted by presses. Alternate rectangles must, of course, be left on the trunk, and these can be removed at the next tapping, when the exposed parts of the tree are sufficiently healed. To secure perfect vitality in the tree, it is preferable to tap it only over a third of its circumference every five years. If properly carried out, the collection of balata rubber is a very profitable industry. One traveller in French Guiana, who was accompanied by three men, collected 666 litres of juice in 119 days, which produced, on coagulation, 720 lbs. of rubber. It is estimated that a single balata will supply 2 lbs. of rubber every year without suffering to any appreciable extent from the tapping. The system usually employed for securing coagulation is to pour the liquid into large shallow pans, about 4 inches deep. A hard crust very soon forms at the surface, and this is removed to allow of another crust forming, and so on until the whole of the juice is solidified. The crusts are then hung on lines to dry. The balata rubber, though perhaps slightly inferior to caoutchouc for certain purposes, and notably as an insulating medium, is yet specially adapted for a great many uses, such as machinery, belting, mackin-

toshes, surgical appliances, &c., but its merits are so far recognised that a considerable trade has grown up during the past two or three years in the Guianas. While the exports of balata rubber from British Guiana in 1881 were only 41,000 lbs., they were no less than 363,480 lbs. in 1889, and though the total fell to 237,450 lbs. in 1892-93, the value has been rapidly increasing. In Dutch Guiana the industry has not been carried on in such a systematic manner, nevertheless two American companies are exploiting the balata on a large scale, and are sending the product to the United States. That the industry can be made a very profitable one may be seen in the price paid for the rubber, which varies in Paris from three to eight francs per kilogramme (kilogramme = 2·204 lbs. avoirdupois), according to quality. It is evident that, while industrial enterprise, says Consul Merritt, is lying under a cloud in South America, it may be to the interest of capitalists to turn these balata resources to account. In this connection, a few notes are added to show the condition of German rubber companies. The new buildings of the German Rubber and Guttapercha Goods Company (formerly Völpi and Schlüter) at Berlin, erected during the latter part of 1894, are now occupied. The dividend for 1894 was 4 per cent. The products are mainly supplies for railroads, and the capital is 1,400,000 marks (£70,000). At the general meeting of the Mannheim Rubber, Guttapercha, and Asbestos Factory, it was resolved to pay at once a dividend of 8 per cent. The dividend declared on the business for 1894 of the United Berlin Frankfort Rubber Goods Factory was 8 per cent., and the same for 1895. An exceptionally good showing is made by the Hanover Rubber Comb Company—a joint stock company. Their profits for 1894, after ample provision had been made for the usual reserves, permitted a dividend of 21 per cent. to be declared. The dividend for the preceding year amounted to 17 per cent.

MUSHROOM INDUSTRY IN FRANCE.

The cultivation of mushrooms in France is a special industry in the department of Seine et Oise, near the city of Paris. It is also carried on, to some extent, in the departments of Drome, Correze, Nord, Marne, and Gironde. The cultivation is a matter of ancient history in France, while the variety of mushrooms is infinite. Some are so small that they can not be seen by the naked eye, and some are so large that, according to a French authority, they became a species of beefsteak. These latter are called *cèpes*. When the French began to make beds for their melons, they noticed that large numbers of mushrooms would suddenly appear on the little mounds. They were as profitable as the melons, if not more so, but they could not be certain of a crop; and not until Heurtot and Legrin investigated the matter did they know whether a mushroom would appear. These two scientific men, followed by Bernaudot, Brique, Gèrard, Barrè, Barrin, and others, spent long and
laborious years on experimenting, and at lengt
covered part of the mushroom's secret, *i e.*, the
ditions under which it pleased the vegetable sp
to grow. The result is a consumption of mushr
in France which is enormous, and is a source of
siderable profit to everyone concerned in the indu
The mushroom loves a place that is cool, damp
dark, or at least it does not seek sunshine, and
has a decided effect upon its colour. If the sun
reaches it, it will be reddish brown—that is, its
or cap—but allowed to grow in the darkness, es
ally in caves, it will be white, fat, and partic
nutritious. It is for this reason that the mushro
almost invariably cultivated in subterranean exc
tions throughout France. The United States Co
at Nantes says that in the department of the S
alone there are over 3,000 caves in which mushro
are grown, and in these places about 300 pe
called *champignonistes*, live, who rarely see the
light. The descent into these caves is by wa
rope ladders. The manure, which is mixed with
damp earth in making the beds for the "spawn
simply thrown down the mouths of the caverns.
galleries lead in all directions, and are usually
about 2½ feet to 10 feet high, but unless the ceili
at least 5 feet high, the work of spreading the ma
is difficult and very fatiguing. Sometimes the ceil
are so low that the men can only work in a knee
posture, and as they must carry miners' lamp
their caps, are almost stifled. These caves are ge
ally exhausted stone quarries. The rent of th
varies from £6 to £24 per annum, according
extent, height of ceiling, ventilation, &c., but t
must be protected against any sudden change
temperature. Moreover, it is highly important t
the air currents move invariably in the same directi
that is, from north to south. The temperature sho
be about 48° Fahr. to produce the best results.
making of the beds is a very important matter;
even of greater importance, if possible, than
temperature and air currents. A very dry and cl
place near the mouth of the cave is selected—a pl
where water can be readily obtained. The requi
quantity of manure having been laid down, it sho
be allowed to lie for several days, after which
beds are prepared. The smallest beds made
France are about 16 feet long, 13 feet wide,
3 feet high. In making these beds the manure m
be thoroughly worked, and any matter foreign to
manure is thrown aside. The beds at first are ab
3 feet high, but the beating and pressing into fo
finally gives them a height of a little under th
When this height is reached, they are raked so th
every particle of foreign matter may be remov
Then they should not be disturbed in any way for
least six or seven days. At the end of seven d
the beds are again worked and watered carefully; th
are then re-made and allowed to rest another we
at the end of this time—that is, a fortnight from
beginning of the work—the surface will be ve
brown, and fermentation very active. The manu

have lost its original colour, and the interior of bed will be deep brown in colour, with white s, indicating where fermentation was most active. this stage precisely the same process must be through as in the first turning, and the mass t be allowed to rest three days. It should then soft to the touch, but leave no moisture on the l. The temperature in these cases must be care- watched, and it will not do to plant the *blanc* pawn if the fermentation be too active. The first must always be allowed to pass off. When the s show signs of drying, they are evenly watered prinkled, the finer the sprinkling the better the lt. Forty days after the *blanc* or spawn has been nly planted over the beds, the mushrooms will ear, and cones or beds will produce a continuous for three months, provided the holes left by the acting of the mushrooms are filled again and ed over, but not otherwise. The seed, spawn, *ence*, or *blanc* (*mycelium*) is usually supplied by ket gardeners in France. It is sold in the shape brick or cake, and the gardeners get it from the melon beds. If kept on a dry, ventilated place, ill not spoil for several years. Having produced spawn, and prepared the beds, there remains e to be done except planting the bricks. In nting, the surface of the bed is scooped out, ording to the size of the brick, and to the depth about 1½ inch. The brick is pressed into the rture and covered with the mixture scooped out. bed must be neither too hot nor too cool when bricks are planted. Mushroom growers generally ide by the amount of moisture left on the hand by ching the bed, as to the time to plant the spawn. n the brick there is any appearance of verdigris, it st be thrown away, as it will produce a poisonous shroom. Several days after planting the bricks, filaments will push to the surface and cover the und, and now is the time for what is termed by growers the *goptage*. This is a term which means ing the beds a cover of prepared earth. In the ne quarries the refuse of the cuttings is sifted, and finer part is called *bousin*. This is mixed roughly with light earth in the proportion of one t of earth to three of the *bousin*. The mixture is inkled until it is sufficiently moist to retain the print of the hand. Then, with the aid of a smooth oden shovel, the bed is covered with this paste. rty days after the *goptage* the first mushrooms will pear. The action of the *bousin* on the mushroom lue to the salts of nitre or saltpetre, which furnish plant with an abundant supply of nitrogen. The tivation of mushrooms in the open differs but little m the method pursued in caves and cellars. The paration of the bed is precisely the same as those lerground, but the bed itself should, if possible, be de on light soil. The mushrooms will appear in rch, and continue until May. The bed is not wed to become too dry, but is sprinkled morning l evening. Careful scientific investigation has wn that the very life of the mushrooms depends upon a good supply of saltpetre, and acting on this, growers have been able to secure a growth of mushrooms at all seasons. In the caves the mushrooms are gathered at about one o'clock in the morning, and two hours afterwards are on the stalls in the markets. In plucking great care is exercised not to tear away from the bed the very young musrooms at the roots of the one that is ripe. As regards the preserving of mushrooms, the oldest method, and the one generally employed, especially for household purposes, is that of drying. The process of preserving them in oil or melted butter is more costly than drying, but the aroma and flavour are retained. The mushrooms, after being drained, are placed, one by one, in wide-mouthed bottles, and melted butter or warm olive oil is poured over them. The bottles are then sealed, and put in a warm place. There is great danger of fermentation, especially in the case of the melted butter, if the temperature of the storage room is too high. This system of preservation is resorted to mostly by householders or dealers on a small scale. The large manufacturers invariably employ the following process:—The mushrooms are peeled and thrown in water, made slighly acid with vinegar. They are then allowed to drain well, after which they are plunged in boiling butter, until they are half cooked, and then placed one by one in wide-mouthed bottles. Each bottle must contain three-fourths of its full capacity. The bottles are now well corked, and the corks tightly and very securely held in place by strings. Then the bottles are placed in large vessels of cold water, the bottoms of which have been covered with straw, while the bottles are also wrapped in straw, to prevent breaking. The vessels of cold water are then put on the fire, and the water slowly brought to the boiling point, which should continue ten minutes. The vessels are then taken from the fire, and the water allowed to cool gradually, after which the bottles are removed and sealed with wax. The annual crop of mushrooms in France is valued at £400,000, and in Paris alone there are 60 wholesale firms dealing exclusively in them.

THE KRUPP WORKS AT ESSEN.

More than 1,250,000 tons of coal are annually consumed by the famous Krupp works at Essen, Westphalia, commenced in 1810 by Peter Friedrich Krupp, and now in possession of Herr Friedrich Alfred Krupp, member of the Reichstag. The establishment consists, according to the *Eisen Zeitung*, of two steel works, with 15 Bessemer converters; four steel works with Siemens-Martin open-hearth furnaces; iron, steel, and brass foundries; puddling, melting, re-heating, and annealing furnaces; draw benches; a hardening and tempering department; file manufactory; rolling mills for plates, rails, and tyres; railway spring and wheel manufactory; steam hammers, forges, axle-turning shop, boiler shop, engineering and repair shops.

Besides the above and many other departments at Essen, connected with the making of cannon, there are steel works at Annen, in Westphalia, three collieries in Westphalia, besides participation in several others; 547 iron mines in Germany; various iron mines at Bilbao, in Spain; four iron works, including one at Duisberg, one at Engers, one at Neuwied, and one at Sahn; various quarries of clay, sandstone, &c.; four steamers, and artillery ground at Meppen, Hanover. The property owned extends over 974 hectares (hectare = 2·47 acres), and the number of hands employed in the mines and steel-works is 25,301. There are, altogether, 1,500 furnaces of various kinds, 3,000 engines and machine tools, 22 roll trains, 111 steam hammers, 2 hydraulic presses, 263 stationary boilers, 421 steam-engines, representing, together, a force of 33,139 horse-power, and 430 cranes, having a collective lifting power of 4,662 tons. The total length of the shafting is 8·8 kilometres ($5\frac{1}{2}$ miles), and that of railways, standard and small gauge, 85 kilometres (53 miles), worked by 32 regular trains with 33 locomotives. The annual consumption amounts to 1,253,161 tons, and there are 573 arc and 1,804 incandescent electric lamps.

POPULATION OF GERMANY.

The results of the last census (1895) of the German Empire (the census being taken every five years, in December) have produced some surprise in that, notwithstanding the alleged depression in agricultural and manufacturing industries, the figures show an increase greater than any census since the formation of the Empire. The population, according to the official figures, is 52,244,503, an increase since December, 1890, of 2,816,027, or 1·14 per cent. increase per year. The per-centage of the previous censuses were—In 1871-1875, 1 per cent.; 1875-1880, 1·14 per cent.; 1880-1885, 0·7 per cent.; 1885-1890, 1·06 per cent. A striking illustration is given by a comparison with the figures of the French census. The increase in France for the same period (1890-1895) was but 124,000, an annual average of 0·07 per cent. of its population, the United States commercial agent at Weimar comments upon this remarkable difference which has attracted considerable attention in both countries. In 1871, at the foundation of the German Empire, its population was 40,997,000. The per-centage of increase differs vastly in northern and southern Germany. In the former, the annual increase was 1·29 per cent.; in the latter, only 0·71 per cent. This must be attributed in a great measure to the highly developed mining industries of the Rhineland and Westphalia, where the soil, besides its hidden mineral wealth, is devoted to agriculture. The southern States—Bavaria, Baden, and Wurtemburg—being more mountainous, offer less opportunities for agricultural pursuits, and are favoured with less natural riches. It is again noticeable that those provinces which are ultra-agrarian show a very favourable increase. The numl marriages, which showed a decrease from the r of the eighties, has increased since 1892. A looked for increase is shown in the rural popula

General Notes.

TOBACCO GROWING IN GERMANY.—Accordi a recent official statement the number of to planters in Germany in 1895 was 157,019. Of there were 76,905 in Prussia, 44,008 in Baden, 1 in Bavaria, and 12,578 in Alsace Lorraine. estates planted with tobacco reached the numb 234,370. Prussia contained 98,146 of this total ber of estates, and it may be mentioned that 4 lay in the province of East Prussia alone. Wh in Prussia the smaller estates are the rule the re is the case in the other States mentioned. extent of the farms planted with tobacco in the 1895 is 52,394 acres, that is 8,966 acres more th 1894. All the estates above-mentioned share ir increase, Baden taking the first place with 2 acres in 1895, as against 17,167 in 1894. In Pr the extent of the farms was 15,435 acres; in Ba 9,019, and in Alsace Lorraine 4,218 acres. Gern grows more than one-half of the tobacco whi annually consumes. The consumption of tobac 1894 was 159,000,000 pounds or a little over t pounds per head, and the crop in that year 84,000,000 pounds, or 4,806 pounds per hectare (tare equals 2·47 acres).

THE GROWTH OF SHANGHAI.—The report for of the Municipal Council of Shanghai is interes says Consul-General Jernigan, as showing the gr of the city in population and as a manufactu centre. In 1885 the population was 125,666 1890, 171,950; and on June 1, 1895, 245,000. figures represent the number living within the for settlement of Shanghai, and not the residents of native city. The native (Chinese) city is enclose a wall, and contains about 200,000 inhabitants. the number residing in the foreign settlement, a 5,000 are foreigners, composed of all nationali but in numbers dominated by British. The for settlement has a police force of 500 and a mili organisation of about 400. The military organisa is composed entirely of foreigners, and is w equipped as infantry, cavalry, and artillery, regul officered and drilled. From the opening of the of Shanghai, about fifty years ago, to within the five years, it was chiefly an emporium for the tribution of goods from foreign countries and export of the staple articles of Chinese trade, now it is fast becoming a great manufacturing cen Before 1890 there were only five mills within settlement, or adjoining the outside roads; there are 53 erected, or nearly completed, and th embrace cotton mills, silk mills, and other factorie

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communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

"OWEN JONES" PRIZE.

This competition was instituted, in 1878, by Council of the Society of Arts, as trustees the sum of £400, presented to them by the en Jones Memorial Committee, being the lance of subscriptions to that fund, upon ndition of their expending the interest reof in prizes to "Students of the School Art who, in annual competition, produce best designs for Household Furniture, rpets, Wall-papers and Hangings, Damask, intzes, &c., regulated by the principles d down by Owen Jones." The prizes are arded on the results of the annual competition of the Science and Art Department.

ix prizes were offered for competition in present year, each prize consisting of a nd copy of Owen Jones's "Principles of sign," and a Bronze Medal.

he following is a list of the successful didates:—

d, Arthur, School of Art, Macclesfield.—Design r wall-tiles.

es, Cecil, School of Art, Coalbrookdale.—Design r painted bowls.

shaw, Agnes, School of Art, Sheffield.—Design r a casket.

ner, James H., School of Art, Huddersfield.—esign for gesso ceilings.

smith, Lizzie G., School of Art, Corporation-reet, Glasgow.—Design for a carpet.

ovat, Henry, School of Art, Cavendish-street, anchester.—Design for stained glass.

he next award will be made in 1897, when prizes will be offered for competition.

Proceedings of the Society.

CANTOR LECTURES.

PRECIOUS STONES.

By Prof. Henry A. Miers, M.A., F.R.S.

Lecture II.—Delivered April 20, 1896.

Having seen how precious stones may be distinguished by means of their density, we can next consider how the *optical* properties may be used for purposes of identification. Here, as with the specific gravity, it is possible not only to make accurate numerical or quantitative measurements, but also to apply simple comparative or qualitative tests. One of the most important quantitative tests is that of the refractive power.

To determine with accuracy the refractive power of a transparent mineral it is usual to cut out of it a prism with a pair of smooth polished faces inclined to each other at an angle of about 60°, and to observe the course of a beam of light across the prism through these faces. This is done by means of a goniometer, an instrument consisting of a graduated circle with an axle on which the prism can be fixed in any desired position; of a "collimator" tube having at one end a slit through which the light falls upon the prism after passing through a lens at the other end; and of a telescope by which the slit may be viewed through the prism. The graduated circle renders it possible to determine the angle between the axis of the collimator and the axis of the telescope, that is to say, between the direction of the light as it falls upon the prism, and its direction after refraction through the prism. The refractive power is measured in the following way.

Both the prism and the telescope are turned about until the angle between them is as small as possible, the illuminated slit being kept in view through the telescope, and this angle—the least angular deviation which the light can experience in its passage through the prism—is read upon the circle. If this angle be D, and the angle between the two prism faces be A, the refractive index, which is taken as a measure of the refractive power of the mineral, is given by the simple expression—

$$\frac{\operatorname{Sin} \frac{A + D}{2}}{\operatorname{Sin} \frac{A}{2}}$$

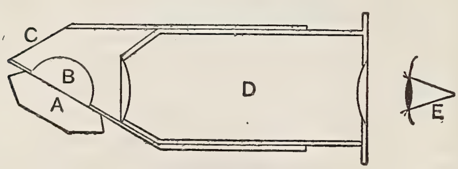
The angle A is easily measured with the same instrument.

The goniometer enables one at the same time to measure the dispersive power, for if the refractive index for one colour be different from that for another, the image of the slit for violet light is formed at a different place from the image produced by the red rays. Hence with the mixed light of day a spectrum will be seen extending from the one point to the other; but by using light of a single colour a clear and simple image of the slit will be seen in the telescope, and then the corresponding index can be measured. The "dispersion" is measured by finding the refractive index for blue light and also that for red light, and subtracting the one from the other.

Such a method for measuring the refraction and dispersion seems at first sight quite unsuited for ordinary use, since it involves the preparation of a prism, and we cannot sacrifice a piece of any jewel for this purpose. But in reality the method is easily applicable to facetted stones if they are unmounted, for in these the lapidary has virtually supplied us with an appropriate prism, ready cut and polished. It is generally possible to find among the facets of a cut stone two which are inclined at a convenient angle, and to make use of these for our prism. The remaining facets may be covered with paper or blackened with ink so that the beam of light whose deviation is measured has only passed through the two chosen facets.

As a qualitative test the refractive power may be very conveniently measured by the method of total reflection. For this purpose a little instrument called the "reflectometer" is used; a tube carries at one end a hemisphere, B, of dense glass, with its plane face inclined obliquely to the axis of the tube; this is illuminated from above through an aperture, C, and is viewed (E) through an eye-piece at the other end of the tube; on the eye-piece is engraved a vertical scale.

FIG. 4.



THE REFLECTOMETER.

The instrument is held in one hand, and, the flat surface of the hemisphere having been moistened with a drop of some highly refracting liquid, a smooth facet of the stone, A, is pressed against it. On looking into the eye-piece two faint shadows are seen crossing
field of view; one of these (at, say, the
division of the scale) occupies the same pos
whatever stone is being examined, while
other crosses the scale at different points
different stones; suppose it to be 22 for
particular stone under examination. T
shadows are caused by total reflection; l
falls upon the flat side of the hemisphere a
inclinations and reaches the eye-piece
different degrees of brightness, accordin
it has been totally reflected or not.

The part of the scale beyond 38 (in the
ticular instance which we have chosen) co
sponds to light which has been totally refle
from the liquid at the surface of the glass
is perfectly bright; below 38 the light w
enters the eye-piece has passed through
film of liquid, but has been totally reflecte
the surface of the crystal for all that portio
the scale which lies beyond 22. Below 22
much less light enters the eye-piece for it
been partly refracted away through the crys
that portion of the field is comparatively d
giving rise to the appearance of a shadow.
have only then to graduate the instrument
examining a number of minerals of kn
refractive index and noting where the sha
crosses the scale for each, and then wher
come to examine any new stone we ca
once say, by the position of the shadow,
is its refractive index, and therefore wheth
is a topaz, tourmaline, beryl, or other min
You will remember that total reflection
takes place when light passes from a mor
fractive to a less refractive substance; if, th
fore, it is to take place at the surface of
stone where the light strikes it on leaving
liquid, the stone itself must have a less re
tive power than the liquid. For this reason
method can only be applied to those min
whose refractive index is less than 1·66
greatest index of refraction yet obtained in
transparent liquid), that is to say, those
lie above spodumene on the diagram; t
with a higher index of refraction give no sha
at all. Until a more highly refractive liqu
discovered the other gem stones cannot b
amined with the reflectometer, but for any s
the instrument at once shows whether th
fractive index is greater or less than 1·66.

We must now pass to a class of wond
optical properties which are absolutely pec
to crystals. These properties depend
the fact that all the precious stones ex
diamond, spinel, garnet and opal are "do
refracting."

Vhen a ray of light falls upon a doubly-acting crystal, it becomes divided into two tinct rays which travel in different direc- ns within the crystal. For this reason any ect viewed through such a crystal appears ible. Iceland spar is the mineral which is st strongly doubly-refracting.

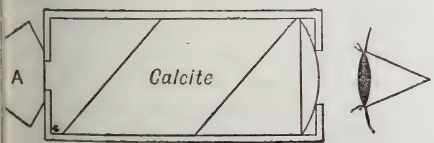
he double refraction is best measured by goniometer. Just as we found that the persion of a crystal produces with white nt a band of coloured images, so will its ible refraction produce, even with a singly oured light, two distinct images of the slit en it is viewed through the telescope across crystal.

o each of these images corresponds a re- ctive index; consequently when we attempt determine the refraction of any precious ne we find not one but two refractive indices; double refraction is measured by their erence. Diamond, garnet, and spinel are only crystallised precious stones which e single refraction; thus the two refractive ices for zircon are 1·970 and 1·920, so that double refraction of zircon is expressed by number ·050 or 50 thousandths. The double action of iceland spar is no less than 172. e double refraction or "birefringence" of h mineral in thousandths is given after its ne in the diagram Fig. 3, p. 761.

he "o" after diamond, garnet and spinel, nifies that they possess single refraction, ing only one refractive index.

Not only does a doubly refracting crystal e two images, but unless the crystal is ite the two images are themselves differently oured and the colours are more or less racteristic of each stone. This property is own as "pleochroism," and it is observed a little instrument called a "dichroscope." g. 5.) This consists simply of a tube ing a small aperture at one end, and at other a lens which is focussed upon the rture; the tube contains a piece of Iceland r (calcite). The gem stone, A, is held in nt of the aperture and is viewed through the s.

FIG. 5.



DICHROSCOPE.

By this contrivance the two beams of light duced by the crystal are more widely separated by the Iceland spar, and give rise to two coloured images of the aperture, which are seen side by side, and can be easily contrasted. The minerals which show the most characteristic colours are ruby, sapphire, tourmaline, and cordierite, or water-sapphire as it is sometimes called.

A further peculiarity of the light which has passed through a doubly-refracting crystal is that it is polarised. Without attempting in the short time at my disposal to explain the nature of this polarisation, I may show upon the screen the curious effects produced by a gem stone when it is observed in polarised light. The instrument used for this purpose is the polarising microscope, or polariscope; it consists of a tube carrying at each end a double piece or prism of Iceland spar, so constructed as to convert any ray of ordinary light which falls upon it into a single ray of polarised light, instead of the usual double ray. In the centre of the tube, upon a little microscope stage, the stone is placed, and upon each side of it is a lens like a large microscope objective, which concentrates the light upon it in all directions. Owing to its own double refraction, the stone imparts to the light that passes through it a tint which depends upon the direction of the rays, and the result is a coloured pattern of a curiously regular geometric shape. This tinted pattern, which is called an "interference figure," consists of curved bands of spectral colours, and it may be of two sorts.

Some stones give rise to a set of circular rings intersected by a black cross; they are known as "uniaxial" minerals. Others give rise to a set of oval rings surrounding two centres which are the apices of the two branches of a black hyperbola; they are known as "biaxial" minerals. Garnet, spinel, diamond and opal possess no double refraction, and therefore do not give rise to an interference figure at all.

It is stated on the diagram (3) in each case whether the mineral is uniaxial or biaxial. The interference figure gives still more information about the birefringence, for if the rings are narrow they indicate strong double refraction; if they are broad the double refraction is weak.

Crystals are further distinguished as positive and negative, according as a test crystal when placed in a certain direction over the stone which is being examined has the effect of adding its double refraction to that of the stone or of subtracting its own double refraction from that of the stone. The test crystal used is a thin film of mica in the case of uniaxial minerals, and a thin wedge of quartz in the case of biaxial minerals. The effect of the test crystal is shown by the expansion or contraction of the rings in the interference figure.

[The distinction between positive and negative, uniaxial and biaxial, &c., was shown in a number of crystal sections, whose interference figures were thrown upon the screen by means of a projection polariscope.]

All these properties can be determined with a facetted stone provided that it is unmounted.

There is a difficulty connected with the interference figure of a facetted stone that with an inexperienced observer is almost fatal. In order to see the interference figure the stone must be turned into the appropriate position, and it may happen that the stone is so facetted that in this position one is looking at a pointed corner, and cannot see through it; just as we saw that the light could not penetrate a facetted aquamarine when it fell directly on the surface. This will be due to the fact that the emerging light is refracted away, or is totally reflected within the stone. The difficulty, I find, can always be surmounted by immersing the stone in some liquid of high refractive index, such as glycerine or oil, or bromonaphthalene contained in a corked tube. Light passing from the liquid into the stone suffers little refraction; it travels through the stone, and the interference figure can be easily seen.

[This was shown by placing a facetted topaz in the lantern, when it appeared opaque upon the screen. On immersing the stone in oil it at once became transparent.]

There are two other characters not connected with light, but peculiar to crystals, which are of some value for the identification of precious stones. One is the cleavage—the tendency of a crystal to split along certain smooth plane surfaces.

Diamond splits in such a way that it can be cleaved into an octahedron; a property useful to the diamond cutters, since it enables them, without the great labour of grinding, to split the stone into something of the shape and size of the brilliant, before it is put upon the lapidary's wheel.

Topaz possesses an equally marked cleavage, but in one direction alone; a glittering surface due to the splitting of the stone in this direction can almost always be distinguished upon the edges of a rough topaz—and faint cracks due to the same cause can often be seen inside a facetted topaz, even though it be alm absolutely free from flaws.

Another still more startling property p sessed by certain crystals is one which am precious stones belongs to the tourmaline alo A crystal of this stone, whenever it is be warmed or cooled, becomes electrified; it comes positively electrified at one end negatively at the other. The effect is not v strong and it might be imagined impossible make use of this curious property for the ide fication of the mineral. But it can be used virtue of an ingenious device lately inven for making such electric charges visible to eye.

Take a mixture of finely powdered red le and sulphur, and dust it through a muslin si on to a crystal of tourmaline, which has b warmed over a spirit lamp and is cooling. stead of lying as an orange powder unifor distributed over the crystal as it would be o any stone without an electric charge, powder becomes separated into its cons tuents, the red lead flies to one end sulphur to the other; the one end is seen become red and the other yellow. This because the red lead and the sulphur elect each other by friction in passing through sieve, the sulphur becomes negatively and red lead positively electrified; unlike elect cities attract each other, so that the sulp flies to the positive end and the red lead the negative end of the crystal. Being held electric attraction the powder cannot be eas shaken or blown off as it would be from unelectrified crystal.

This closes the list of properties which practically useful in the discrimination precious stones. As an example, I may su marise the various tests which we might ap to a rough topaz and a facetted tourmali respectively.

The rough topaz will be seen, if carefully amined on its edges, to show traces of cleava in one direction in the shape of little smo flat surfaces; a small chip broken off will sh this even more clearly, it will be a flake.

This flake dropped into methylene iodide w sink, showing that it has a specific grav higher than 3·3. The same flake placed the polariscope will give a biaxial interferen figure, and the use of the quartz wedge w show it to be positive. The breadth of t coloured bands indicates to an experienced e that the double refraction is not strong.

By means of the total reflectometer both t refraction and the double refraction may curately measured; two shadows will be en to cross the scale—one at the number rresponding to the index of refraction 1·63, e other to 1·62; the double refraction being e difference between these two is ·01, or out 10 thousandths.

Examined with the spectroscope the crystal ves no absorption, and is therefore neither rcon nor almandine garnet.

If it be desired to find the specific gravity e fragment can be dropped into the thallium-lver nitrate, which is then diluted with water ntil the fragment just sinks. A little further arming will drive off a trace of the water, and e fragment of the stone will remain sus- nded. Test fragments of other stones being opped into the liquid some will float and me will sink, but a piece of topaz will do ither. We have already, however, obtained ch convincing evidence from the optical pro- erties alone that it was not necessary to rsue the investigation so far. Its refractive dex alone was sufficient to distinguish it from rysoberyl, the only stone with which it might confused by its position on Fig. 3; and e whole determination may be made on a agment about the size of a pin's head.

Take next our facetted tourmaline. If it is t mounted in a setting the specific gravity n be easily found to be exactly 3, or that a test piece of tourmaline, by means of the ethylene iodide, in which it floats until the quid has been slightly diluted with benzene.

Pressed against the reflectometer the shadow once appears on the division of the scale, rresponding to an index of 1·63. Examined the polariscope it is seen to be uniaxial nd negative. These three observations are ough to determine the mineral with accu- cy.

Further, in the dichroscope, it shows a most ronounced difference of colours, far more riking (if the stone be a brown tourmaline) an that shown by any other mineral. Even if be mounted in a setting, the refractive index, s determined by the reflectometer, fixes its osition on the scale-diagram (Fig. 3) in the eighbourhood of diopside.

But take the tourmaline, warm it, and dust it ith the mixture of red lead and sulphur—the lectrification at once shows it to be tourmaline. his test I have frequently applied and have ever known it to fail; it serves to distinguish urmaline with certainty from diopside with hich it might easily be confused; there are everal other stones with which it might be nfused on account of its wide range of colour, with spodumene for example, or axinite, epidote, or idocrase. I have certainly known tourmaline sold as all these minerals. Their superior brilliancy is generally sufficient to distinguish either spinel or ruby from a red tourmaline. In fact the refractive index of tourmaline is so much less than that of any stone which it resembles, that the reflectometer at once identifies it. The other minerals have a refractive index greater than that of the bromonaphthaline, and give no shadow in the instrument at all.

Take again any other pair of stones which are liable to be confused, garnet and ruby for example. A glance at the diagram will show how they are to be distinguished. The specific gravity will scarcely suffice, but ruby is uniaxial, negative, and has a double refraction of $\frac{8}{1000}$, whereas garnet is generally singly refracting, and even if it does show a weak double refraction will never give the uniaxial figure.

Take again the true jacynth, which is a brown zircon, and the false jacynth, which is a brown garnet, both the high refractive index and the strong double refraction, as well as the high specific gravity distinguish the zircon at once; and by the same characters a colourless zircon is easily distinguished from a lux sapphire, which it very closely resembles. But in reality a mere glance at the stone through a spectroscope will identify it if it be a zircon; the characteristic bands in the spectrum can not be given by either a sapphire or a brown garnet.

There is a curious and widely prevalent confusion between olivine and the beautiful green garnets found in the Ural mountains; the latter are almost invariably known in the trade, and are sold, as olivine.

Now, olivine is biaxial and posseses a strong double refraction; the garnet, on the contrary, is almost if not quite free from double refraction. There can be no possible similarity between the two stones except as regards colour, but there is a popular prejudice against garnets, and I suspect that this largely accounts for the selling of these stones under a wrong name.

Most important of all distinctions is that between any true gem stone and its imitation in glass or paste. In this matter there are simple tests which need never fail. Precious stones are imitated with great skill; compositions are made which not only resemble the true stone in colour but by the use of lead-glass and other dense compounds they may have as high a refractive index as some of the stones and as great a specific gravity. But you will never find that both the refractive index and the specific gravity are those of the true stone. The imitation will not find a place in our diagram scale. Again, the imitations are not ever so hard as the true gem stones; they can be scratched with a knife. But the most important and an absolutely infallible criterion is the fact that the imitations are not crystals at all, and can never show the double refraction or the dichroism of the doubly refracting jewels.

I may mention that it has just been stated by a French observer that the newly discovered X-rays afford means of distinguishing between certain gems and their imitations. True ruby, or sapphire, or true turquoise are like flesh—transparent to the X-rays; but their imitations are like bones—opaque to them.

There is, however, one totally different class of artificial jewels which have only recently come into existence that must be considered quite apart, namely, true crystallised gem stones produced by artificial means. Innumerable have been the attempts to manufacture true diamonds, and at length they have been crowned with success; by more than one process diamonds have now been manufactured — most successfully, perhaps, by the method of M. Moissan, who, by the intense heat of the electric furnace, dissolves charcoal in molten iron, and by cooling under pressure, induces it to separate out as crystallised carbon or diamond.

It is quite possible that we have here a reproduction of the actual process by which diamond has been produced in meteorites. It may not be generally known that some of these curious pieces of iron and stone which come to us from outer space have been found to contain true diamonds.

Moissan's diamonds are mere minute specks, and by no means clear and limpid; moreover, they are costly to produce, so that there is little or no fear of their entering into competition with the diamonds of Kimberley. But quite otherwise is it with the ruby; this stone has now been successfully reproduced in Paris, and on a sufficiently large scale to be used in jewellery. The ruby has been made in several ways. (The result of one of the methods employed by M. Frémy was shown by a diagram.) The crystals were made by raising to a very high temperature a mixture of alumina, potassium carbonate, and calcium fluoride. The red colour is obtained by adding a trace of potassium chromate. By ma
taining the temperature for about a we
crystals weighing one-third of a carat w
obtained without great difficulty.

Now, these stones cannot be distinguis
from the natural ruby by any of the te
which I have described. They possess
specific gravity, the refraction and the dou
refraction of the natural stone; in the pol
scope they show the same uniaxial interfere
figure. In this there is no cause for surpri
the artificial stone exhibits the same charact
as the ruby for the simple reason that it i
ruby. Other minerals have been reprodu
by artificial means. Turquoise has been s
cessfully made by compressing powdery a
ficial phosphate of aluminium into a comp
mass.

Professor Judd has kindly lent me two she
of paper covered with blue paint; one of th
is painted with natural ultramarine, the ot
with artificial ultramarine. You see that
is as good as the other. So also with
ruby, I can see no reason why it should
ultimately be made as large and as beauti
as any natural specimen; the attempts
reproduce sapphire have not been so success
as regards colour, but here, again, I see
reason to doubt the possibility of excell
sapphires being ultimately manufactured.

Large numbers of artificial rubies are n
used in jewellery. The only respect in whi
they differ from the natural stone is that th
have been formed by a different process.

If we desire to distinguish them it can o
be by some feature resulting from the mann
in which they have been made. From my o
limited observations, I think it is genera
possible to see in the artificial rubies,
means of the microscope, a certain streakin
and also little cavities like bubbles, which o
does not see in the natural stones. Bo
these characters may be due to the relativ
high temperature at which the artificial ston
have been formed, and the comparativ
short time in which they have been produce

In bringing to a close these imperfect a
fragmentary notes on precious stones, I mu
call attention to the chief point which it is r
desire to emphasise. I have indicated how
should myself set to work to determine t
nature of a precious stone. Each observ
can use his own contrivances, but they mu
be in accordance with the principles which
have illustrated. The methods are those
physical science — and they are accurat
personally, I should hesitate to assert po

ly the nature of any precious stone except means of the scientific tests, although I ght have an opinion. It may be my own t of expert knowledge which prevents me n feeling confidence in any but these thods; at any rate, I claim for them that y enable any one with a little practice to ermine with absolute certainty any precious ne, even when it is facetted, and, moreover, y supply, not an opinion, but a proof.

onsidering the number of serious mistakes ich are made in the trade, and the curious ors which prevail, jewellers would surely do ll to learn these methods; to acquire especi- y such a knowledge of crystal optics as will able them to determine the refraction and uble refraction of any transparent mineral. simple microscope, such as geologists use, all that is necessary for the purpose.

t would be, I imagine, desirable for every ge firm which deals in precious stones to gage the services of an assistant possessed sufficient scientific knowledge to make these terminations, for precisely the same reasons ich make it desirable for large manufac- ing firms to engage the services of a entific chemist.

The absolute necessity of accurate scientific owledge in commercial and practical under- ings is now fully recognised.

The jeweller's trade stands almost alone in ling to realise that such knowledge has a al commercial value, and in ignoring the aid physical science. I need not point out that me such knowledge is even more important those who buy than for those who sell ecious stones.

I hope that the effects shown upon the een to-night have made it abundantly clear at precious stones have a great deal more in em than is at first sight apparent, and that, e all other natural objects, they disclose ore and more features of beauty and interest e more closely they are studied.

In the present lectures I have shown or scribed certain effects without a word of planation. My object has only been to dicate how, in one respect, the mineralogical searches relating to the physical properties crystals have a direct practical application, hough they were undertaken in the pure irit of scientific curiosity. In this they semble all researches of abstract science.

In conclusion, I would add that those who re to carry the study a step farther than we ve done to-night, and attempt to explain all ese curious properties, will find themselves in a most fascinating field of discovery and speculation, which has proved attractive to many of the acutest intellects of the present century.

Miscellaneous.

STATE ENCOURAGEMENT TO COMMERCIAL EDUCATION IN SWITZERLAND.

Her Majesty's Minister at Berne, in his last report says that in 1891 a Federal decree was passed, authorising, under certain conditions, grants to commercial schools and societies then existing, or afterwards to be established in the different cantons. Commercial societies have existed in Switzerland since 1863, when the first was established at Zürich, and quickly followed by others in the large towns. At present there are 43 such societies, with 5,319 members, in the principal centres of Switzerland, and also in London and Paris. Nearly all these societies belong to the "Swiss Society of Merchants," having for its aim mutual help, but it also exists for the development of general, and, more especially, commercial knowledge among its branches and their individual members. In connection with the central society, the different local societies give supplementary commercial education by evening classes, hold examinations, and grant diplomas and certificates to apprentices, clerks, and other young persons engaged in commerce. To this central committee, which meets at Zürich, where it has a permanent office, the Federal Government makes grants, to be divided by it among the affiliated branches. These grants are restricted to the salaries of professors, libraries, lectures, examinations of apprentices, the expenses of the registry offices and of the central office. The societies in the smaller districts must contribute at least 40 per cent. of the salaries of professors; those in the larger towns at least 66 per cent. The societies in London and Paris are treated on the same footing as those in the smaller centres of Switzerland. The amount of the grants to these societies from the Federal Government was, in 1894-95, 555,885 francs (£22,235). The decision of the Federal Government to allow grants to commercial schools and societies was arrived at after careful inquiries into the existing state and requirements of commercial education as a preferable way of encouraging and supporting such education, to establishing a central school or endowing professorships at the universities. Subsidies are given to commercial schools on the following conditions:—(1) The school course must continue for at least three years; (2) pupils not to be under 14 years of age; (3) the subsidies to be given only towards the actual expenses of teaching, viz., salaries of teachers, purchase of materials and apparatus used in teaching, &c.; (4) the subsidies are not to exceed a moiety of the sums contributed from local sources, and these are not to be diminished in consequence of the subsidies. In addition to the above conditions, it is required that all schools in receipt of subsidies shall submit their schedules of studies, examinations, and expenses to the officials appointed by the Federal Department of Commerce, and that they shall always be open to inspection by the latter. In order further to encourage and assist commercial education, purses are granted to poor and deserving scholars so as to enable them to continue their studies either at other cantonal schools, at the Swiss universities, or in other countries. The students who go to other countries are encouraged to enter banks or other houses of business, and, at the same time, to attend classes at the universities of such countries; they are bound to furnish a half-yearly report of their work. By this means it is hoped that a sufficient supply of teachers will be provided for the commercial schools, who will be able to lecture on commercial subjects with authority, having had both practical and theoretical training in such subjects. The disposal of the purses is left to the different schools, subject to the approval of the Department of Commerce, and though the chief end for which the purses are given is to provide teachers of experience, they are also granted to poor deserving scholars to continue their studies to a later age than they otherwise could have done. The number of pupils attending such schools amounts to 728, and of these 167 are foreigners. Some of the schools make no charge on the pupils, and at others the fees range from 30 francs (£1 4s.) to 200 (£8). The latter fee is charged only to foreigners. The total expenses of the schools have increased from 98,590 francs (£3,944) in 1891, to 244,903 francs (£9,796) in 1895; and the subsidies from the Federal Government have increased in the same period from 20,166 francs (£807) to 63,250 francs (£2,530). The total amount of Federal contribution to commercial education, including grants to both schools and societies was, in 1895, no less than 619,135 francs (£24,765).

PETROLEUM INDUSTRY OF ROUMANIA.

The chief petroleum producing districts of Roumania are Prahova, Dâmbovitza, Bacau, and Buzeu, the total annual yield in the wells belonging to private persons being 7,017 tank trucks of 10,000 kilogrammes (10 tons) each. These wells are 751 in number and there are also 47 borings owned by 123 persons in all, and they vary in depth from 60 to 240 metres, the most important sources being situated at Bushtenari, Baicoi, and Campina, in the district of Prahova, and at Glodeni and Colibashi, in the district of Dâmbovitza. Her Majesty's Secretary of Legation at Bucharest says that in addition to the above there are 152 wells and one boring belonging to the State yielding 443 tank trucks of 10 tons each, and if these be added to the above a total for the whole country is arrived at of 7,460 trucks of 10,000 kilogrammes each,
or 74,600,000 kilogrammes, that is about 74,600
of petroleum valued at, say, 400 francs per truck
total amount being 2,984,000 francs (£119,360)
annum. The amount of capital employed in wor
all the wells in the country comes to about 5,235
francs (£209,400). If the number, depth, and
of each district be taken into consideration it wi
found that the wells of Doftanetzi, Bushtenari,
the most productive, with an annual yield of 2
trucks, valued at £41,440. The petroleum
at Câmpina and Baicoi (Prahova) and those
Sarata and Tega (Buzeu) also yield, in pro
tion to their number a considerable quantit
oil. In the district of Bacau, at the wells
ated at Solontz and Moinesti, the yield is
quite so abundant on account of the amoun
fine sand, but the wells in general last longer,
from five to seven years. From a careful stud
the country in general it has been found that
three richest districts of petroleum in Roum
are those of Dâmbovitza, Prahova, and Buzen,
that it is only want of capital and means of trans
to the large railway centres which have preve
their resources from being still further develo
Of the annual yield of 7,460 trucks of 10,000 k
grammes each, nearly 6,000 are used in the works
making refined petroleum, and the remainder is
ported chiefly to Austria-Hungary, but this coun
in order to protect the petroleum of Galicia,
limited the export from Roumania to 2,000,000 k
grammes (2,000 tons), and taxes it at the rate
86 kreutzer per 100 kilogrammes. In 1895, the
duction of petroleum was estimated in Wallachi
200 tons per diem, and that of Moldavia at from
to 70 tons per diem. The small quantity of pe
leum exported by Roumania proves, to a cert
extent, that the natural advantages of the countr
this respect have not been sufficiently developed,
this is due partly to the fact that private enterpris
unwillling to risk further capital in the working of
existing wells, and in the discovery of new ones,
partly to the primitive nature of the borings
hand, which rarely reach a depth of more than
metres. At from 500 to 600 metres, when bori
have been attempted, richer and more plent
sources have been discovered. To remedy this,
has been suggested that the proprietors of w
should unite with the manufacturers of refi
petroleum, and so give a renewed impulse to
industry. This would enable petroleum to
exported in a refined state to Servia, Bulga
North Italy, and even to Germany, by the Danu
the residue being used as a combustible in
factories and for locomotives. In connection w
the above, Mr. Hamilton Browne states that he
been informed that a syndicate has been formed
England for the working of petroleum wells in t
Prahova district of Roumania (also of the wells
Baku, Grosnez, in the Caucasus, and in Galicia), w
a considerable capital at their disposal, and that t
grounds where the chief wells are situated have be

d from their proprietors for periods of from 20 5 years. The modern process of drilling, it is d, will be employed, instead of the primitive of hand digging, and the production, it is ed, will thus be considerably increased.

RODUCTION OF ESSENTIAL OILS IN SICILY.

he essence industry in Sicily is both widespread prosperous, and essence producers and exporters numerous. The essential oils are derivable and ved from the rind of all varieties of the citrus up, albeit they differ considerably in quality. That ressed from bergamot rinds is the best, then follow the order named lemon, orange, and citron nces, the relative values of the essences being inverse order to that of the juices. The British e-Consul at Messina says that the lemons and nges serving for the purpose must be outwardly ct as well as internally healthy and sound, hence se slightly punctured, windstrewn, undersized t, &c., which are utilised for the production of centrated juice are practically valueless in the exssion of essence. The rind is first prepared by king it in cold water for about twenty minutes, ich preliminary operation is conducive to the turity of the oily vesicles, and this contributes greatly, s said, to the ready expression of the oily essence. e rind is next rotated and pressed against a sponge d in the left-hand, and when this has become npletely saturated it is squeezed over a vessel of zed porcelain or of common earthenware. This t yield is far from pure, containing as it does a ll quantity of juice and of mucilage, or other anic matters, which however slowly subsiding, n a deposit at the bottom of the vessel; the liquid t sinks and thus the essential oil is left alone floaton the top. The system of remuneration adopted Sicily is worthy of notice as it allows of the workn being rewarded in proportion to the work permed. They are therefore neither rewarded at a d rate which would encourage idleness by inducing labourer to disregard the amount of rinds which may squeeze, nor are they paid on the quantity rinds employed, which might cause negligence in squeezing of the essence. Every *sfumatore* or *izzatore* is remunerated therefore in proportion to amount of essence he succeeds in extracting out 35 kilogrammes (kilogramme = 2·204 lbs. avoirpois) of rinds, working day and night. This volatile stance, which serves so many purposes, is in such neral demand that it commands good, and on the ole steady prices on the European markets when duced by well-known and respectable firms, so t all adulterations of these substances are carefully rded against, although from the great facilities and ucements offered for adulteration through the ready sorption of some foreign substances, many instances ve occurred of impure essential oils being exported. The most common adulteration of these volatile substances is through the medium of various fixed oils, such as resin and turpentine. Apart from those scientific tests practised by those analytical chemists, whose presence of late in Sicily has contributed to restore the old reputation of the Sicilian essences, tests which are always practically available, there are several very simple methods sufficiently accurate for all ordinary cases which require no chemical training, and in the case of the adulteration having been effected through fixed oils or resins, no special apparatus. Should the foreign matter be an oil or a resin its presence will be revealed by pouring a few drops of the suspected liquid on a leaf of unsized paper and heating it; the heat will cause the volatile particles of the essence to fly off, leaving behind a small oily spot or stain with a strong resinous odour, if a resinous substance has been admixed, but if the substance added to the essence be alcohol, which being a spirit itself could not be detected by the same simple method of evaporation, a somewhat more complicated process is adopted in Sicily, and in the other essence producing regions of Italy, namely, the introduction of a few pieces of chloride of lime into the adulterated essence; these combine very readily with the alcohol and extract it from the essence. There is no doubt however that the frequency of these adulterations had discredited and unsettled the market prices of this article, so that it became imperative, or at least most expedient, in some cases to submit it to analytical test before it was exported, without which it was received abroad with much suspicion unless it bore the trade-mark of some well-known firm. Owing however to the measures taken of late to guarantee the genuineness of the Sicilian essential oils, these have redeemed their character and regained their place on foreign markets. The value of the volatile oil depends wholly on the variety of the citrus whence it is expressed, and that squeezed from the peel of the bergamot is the most highly prized, that of the lemon coming next, while the orange essence only occupies the third place in the scale of values. The quantity of essential oils shipped to all countries during 1895 was 37,941 kilogrammes, valued at 588,085 lire (lire = $9\frac{9}{16}$d.), and the large proportion of 32,010 kilogrammes out of this quantity was taken by Great Britain, the value of the same being 224,070 lire. The figures for 1894 were—total 52,422 kilogrammes, worth 733,908 lire; and to Great Britain 45,626 kilogrammes, valued at 638,764 lire. It should however be mentioned here that in this instance at least the custom-house valuation is apparently greatly in excess of the actual market value of these essences.

THE POLISH ZINC INDUSTRY.

Among the different branches of the mining industry in Poland the working of zinc occupies, after that of coal, the most important place. In the last report of the French Consul at Warsaw it is stated that two companies share the monopoly of the working, namely, the Sosnovice Company, which obtained possession, in 1890, of the mines and workshops of Kramst, and the Derwiz-Szewcow-Pomeranoff Company, to which the Government granted a concession in 1891 for sixty years of the works in the basin of the Dombrowa. The working of zinc ore is exclusively concentrated in the environs of the town of Olkusz. The ore which is found in the greatest abundance is calamine, which yields from 7 to 30 per cent. of zinc. Zinc blend is also found but in smaller quantities. The ore is carried either by carts or by the Ivangrod-Dombrowa railway to the Bendrin and Pauline works, a distance of about 25 kilomètres. There are only two rolling mills in the kingdom—one at Sosnovice and the other at Slawkow. There is also a factory of oxide of zinc. A great increase in the production took place in 1895, comparing this year with 1894. The number of workpeople employed in the zinc industry in Poland amounts to 2,100, of whom 1,400 are engaged in the mines, and 700 in the workshops. The French Consul says that a brilliant future would await the Polish zinc industry if only those engaged in it would introduce an improved system of working and could diminish the cost of production to the level of that in other countries; the national industry would then have little to fear from foreign competition and would realise immense profits.

RAG TRADE OF LEGHORN.

Leghorn, which at one time was pre-eminent among Italian ports in almost every branch of trade, still retains her ancient pre-eminence in several branches, and in none more so than in the trade in rags. Practically the whole rag trade of the peninsula centres in that city, and apparently for no other reason than the fact that traditions die hard in Italy. Leghorn was one of the first cities in Europe where rag-picking was instituted on a large scale, and it is not easy, without good reasons, to transplant or diminish the importance of a market that has for centuries held an unrivalled and unique position. According to the British Vice-Consul at Leghorn, there are some 500 women and girls, and about 50 men and boys, engaged in the rag-picking industry. Their work is all done on the premises of the great establishments. About half a dozen girls stand round square tables piled with an assortment of rags, and surrounded by a considerable number of deep narrow baskets, into which they cast their assortments with wonderful dexterity and rapidity. A rag warehouse has two main divisions: the stacks of mixed and unpicked rags waiting for assortment, and the stacks of carefully assorted rags waiting to be pressed into large bales for shipment. The rags are piled high from floor to ceiling, passages being left by which access can be had to the different assortments. The rag-picking establishments secure their supplies from the small rag shops all over the kingdom, which in turn ei send out itinerant buyers of their own or purc from independent itinerary collectors. The nat thrifty disposition of the Tuscan lower orders, t habit of finding a use for odds and ends of e description, and their love of hard bargaining, con to a larg retail business in rags. Most of the pe sell to the itinerant collectors or *cenciai*, but tl who can afford to wait carry their accumulation the rag shops from the proprietors of which t receive a better price, or if they have collecte really considerable quantity, even direct to the picking establishments where they have a still m remunerative sale. The usual price paid is from to fifteen centimes per kilogramme according quality, but in the palmy days of the rag trade, be esparto and wood pulp came to be used in the ma facture of paper, as much as three times this fig was paid for old rags. In the wholesale market r have for the same reason only half the commer value they had thirty years ago. The greater par the rags which leave Leghorn go to the Uni States which is the principal foreign market Italian rags. Great Britain is scarcely so goo customer even as Spain, and it would seem first sight somewhat curious that a country wh produces so enormous a quantity of paper sho draw so small a supply of rags from Italy. The r reason of the large business with America wo seem to be, that the paper manufacturers of United States are sufficiently enterprising to direct to the Italian rag merchants without the int vention of middle men, either American or Itali thus securing the goods they require on the m favourable terms possible to themselves. This dir relation does not seem to exist between the Engli paper manufacturer and the foreign rag merchant, least in Italy, and the Vice-Consul says that t generality of the English importers of vegetable ra seem hitherto, for no easily assignable reason, have neglected the Italian market. The Vice-Cons goes on to say:—"The writer of the article, 'Pape in the last edition of 'Chambers's Encyclopædi after pointing out that the supply of esparto gra must necessarily fail, and that wood pulp witho rags is useless in the manufacture of paper, ask with a view to future contingencies, 'How mu longer will Belgium, France, and Germany be di posed to part with their rags?" He makes n mention of Italy, which is ready enough to part wi her supplies of this article, and it is well that buye in England should be made aware of the large an varied stocks that exist in Leghorn, where they wi find, not only quantity, but all their requirements to quality. English paper manufacturers, too, woul find a certain advantage in placing themselves direct communication with Leghorn rag merchant not only on account of the saving in cost, but becau of the experience they have acquired in their relatio with America in manufacturers' requirements. A with vegetable rags, so Italian animal rags do n n to be in great demand in the United Kingdom. rchants in Leghorn sometimes send bales of these ds to the market at Dewsbury to be put up at the auctions there, but they object to this course on ount of the great uncertainty of the results.

RITISH ARTISTS IN VENETIAN ART GALLERIES.

The British Vice-Consul at Venice says that it will ve of use to British artists who wish to make ies of works in the Venetian galleries and seums, to know the regulations which were lately ued by the Director of the Royal Galleries, mely, "Article 9, letter *a*, of the regulations with pect to the entrance to the Royal galleries and seums, prescribes that free entrance should be anted to foreign artists when they have a certificate m a foreign institution of fine arts resident in Italy, failing this, a certificate from their own consuls. tists are, however, only to be considered—those ho exercise the profession of artists (painters, ulptors, and architects), and are acknowledged as ch in their own country. Simple amateurs who aw for pleasure are therefore to be excluded, as ell as ladies and young girls, who, because they can ndle the pencil, would like to accompany their thers, mothers, and brothers who are artists, though they are not artists in the true sense of e word. To avoid, therefore, that gratuitous rmits should be given to persons who have no ght to them, I am authorised by the Ministry to quest you to limit your certificates to those persons ly who can prove by documents, or identity, that ey exercise in the country represented by you the rofession of artists, specifying if they are painters, ulptors, or architects, and quoting in your certificate e documents from which it results that they are tists, and excluding altogether simple amateurs or urists who only sketch. Archæologists belonging institutes not resident in Italy, foreign art critics, istinguished persons, &c., can only obtain the per- its to visit and study in local museums and art alleries from the Ministry at Rome, through the iplomatic channel." By a subsequent regulation, was signified that the "tessera d'esenzione," or ee ticket, is only valid for one institute, and that he applicants should make separate petitions on a heet of stamped paper, and obtain a consular ertificate for each institute they wish to visit.

DAMASCUS GUN BARRELS.

The United States Consul at Liège, in his last eport, says that an important feature of the manu- acture of gun barrels in his consular district is the roduction of the entirely handmade Damascus arrel for sporting guns in the valley of the Vesdre, rovince of Liège. The industry dates back for many years, and extends from Nessonvaux to Chaudfontaine, where most of the workmen are gun-barrel makers, the trade descending from father to son; in fact, it may be said, that they are born to the work. Gun factories producing Damascus barrels of superior quality use metals which are the result of a combination of the best primary substances, welded and forged by the *martelage à froid* process. The steel is imported from Westphalia; the iron is manufactured at Couvin; the coal for the numerous forges is obtained from the mines of the highlands of the Herve, situated in the vicinity of this industry, and furnish coal especially fitted for this work. The factories receive their motive power from the river Vesdre. The manufacture of Damascus barrels has increased very much in recent years, owing to the expertness of the artisans and the advantageous geographical situation of the valley, where all the necessary and indispensable elements for manufacturing are united. Every workman has his special part to perform in the manufacture of *armes de luxe*. The men are designated, according to the work they perform, as *appråteur*, *forgeron*, *dresseur*, *aiguiseur*, *polisseur*, *foreur*, *garniseur*, and *reforeur*. Barrels of medium value are made of coke, iron, and steel, but superior barrels, the specialty of the valley of the Vesdre are manufactured from charcoal, iron, and steel. By an ingenious marriage of these metals a composition is obtained which admits of the fabrication of barrels offering all the desirable guarantees of solidity and resistance. Some years ago forges and workshops were entirely engaged in making iron barrels, and there were but few barrel makers who produced tubes or barrels known as twist barrels, called by the French *canon tordu*, or *tors*, from *tordre* to twist or contort. The ingot for the production of the curled damascus, which is the favourite design for fine guns, is composed of about thirty sheets of iron and steel, each having the thickness of 4 millimetres and a breadth of 120 millimetres, which form a square mass about 50 centimetres long, and are enveloped in a box of common thin sheet iron or by small wires at each end. The package thus prepared is put into an oven and welded together at the lowest possible temperature. Too great a heat destroys the metal and yields a burned damascus showing a small if any design. Each barrel receives 150 welding heats while being forged, making 300 heats for a double barrel. If one of these welding heats is unsuccessful the barrel may be a failure, either by the alteration of the damascus or by a trace of the smallest imperfection in welding. Swedish iron is not used in forming curled damascus—only refined charcoal iron of Belgium, which gives a greater contrasting hue to the steel, and can be welded at a lower heat. After the ingot is welded it is rolled into small square rods of 7 to 9 millimetres, according to the design of the damascus desired. The rods are then drawn into ribbons by the barrel smiths, in whose hands they undergo a high degree of temperature in order that every metre of the rod shall show

200 twists. Here, again, the superiority of the charcoal iron is noticed in the fine twist; coke iron can only be imperfectly twisted and gives a coarse damascus. The more charcoal iron is hammered by the smith, the harder it becomes, and the metallic elasticity is increased, while the contrary effect takes place in compositions made from coke iron. The rods twisted in this manner are united in groups of two and six together, according to the thickness of the barrel at the muzzle. The twists are less at the thickest part of the barrel, gradually increasing as the barrel becomes thinner. The ribbon thus prepared is wound round a mandrel, forming a spiral, inside which is placed a sleeve which gives a stiffness to the roll after the mandril is taken out, and also aids in welding the barrel. After the barrel is welded and forged, this sleeve is bored out, the barrel straightened, made lighter, polished, and ground on a grindstone, which gives a more perfect equality in the thickness of the tube than can be obtained with a lathe. The barrels are then garnished and trimmed, which consists in uniting both barrels, together with tin or brass. This process must be done with great care, since the quality of the gun, especially for accurate shooting, depends largely upon it. No official test is given to these *armes de luxe*, but they are subjected to a thorough shooting proof by the manufacturers before delivery. In the valley of the Vesdre are annually produced about 300,000 pairs of Damascus barrels, representing a value of nearly 3,500,000 francs. The principal countries to which these barrels are exported are the United States and England. About half the barrels made in the valley of the Vesdre are sold to the manufacturers in Liege to be mounted. The gun barrels referred to have received high awards at the exhibitions in Paris (1867, 1878, and 1889), Philadelphia (1876), Brussels (1880), Clève (1881), London (1884), Antwerp (1885 and 1894), and Chicago (1893).

General Notes.

HUNGARIAN AGRICULTURE.—The agricultural industry in Hungary employed in 1890 nearly three-fifths of the population, or 9,000,000 of inhabitants out of a total of 15,200,000. A large proportion of the cultivated area is under wheat, and the annual yield varies between 36,000,000 and 45,000,000 of hectolitres (hectolitre equal 2·75 Imperial bushels). The area under barley increased from 911,000 hectares (hectare equal 2·47 acres) in 1881 to 1,046,000 hectares in 1893, and this crop represents a tenth of the cultivated area; maize increased in the same period from 1,080,000 hectares to 2,000,000. The area under beets also increased from 33,000 hectares to 82,000. Viticulture, by reason of the ravages of the phylloxera, fell from 361,000 hectares to 226,000. The area of the forests is now nearly 5,000,000 hectares, t greater part of which belongs to private owners.

FLOWER CULTURE ON THE RIVIERA.—One of t most paying forms of agriculture, in its widest sens on the Riviera, is the cultivation of flowers for expo and for the perfumery factories at Grasse. In Nic in 1894, according to Acting-Consul Jerome, 55,o kilogrammes of violets, 14,000 kilogrammes of jo quils, 11,000 kilogrammes of roses, and 165,000 kil grammes of orange blossoms, as against 50,000 kil grammes of violets, 15,000 kilogrammes of jonquil 9,000 kilogrammes of roses, and 160,000 kilogramm of orange blossoms in 1895, besides large quantities lavender, jasmine and other flowers were used in tl manufacture of perfume (sixteen different kinds flowers are cultivated only for this purpose in tl department of the Alpes Maritimes). The lavend is a semi-wild plant, found in large quantities in tl mountains, especially near Sospel, Luceram, an Lantosque. The cut flower business has been large developed since the introduction of the parcels-pos During the period comprised between October 1s 1895, and May 31st, 1896, 152,271 parcels of 3 and kilogrammes of cut flowers were despatched to diffe ent parts of France and to foreign countries. It officially estimated that the value of flowers annuall exported from Nice, Cannes, Beaulieu, and Menton is 3,000,000 francs (£120,000).

QUARTZ SLATE.—Quartz slate, a highly refractor natural stone, is quarried at Crummendorf, nea Strehlen, Silesia. It is, according to a recen German report, a cheap substitute for the best fire proof brick, and exceeding the latter greatly i durability, it is highly appreciated by all who ar interested in the use of such material. Quartz slat is a mineral of greyish white colour, and is deservin of notice on account of its extremely rare occurrence the Crummendorf quarry being the only one in Germany. Examined by means of a microscope, i shows a fine texture of sharp quartz molecules, which only by the pressure of an enormously high wate column can have been brought into connection. The slate is found in layers from 2 to 10 inches in thickness. Its high contents of silica (91·4 per cent.) make it extraordinarily fireproof, and it can be worked easily on account of its softness. Its fibrous nature excludes the blasting out of particles by expansion produced by heat. Quartz slate will, it is stated, last three times as long as the best fireproof brick, even if subjected to the highest temperatures. Since 1854 it has been extensively used in Eastern Germany, especially in the manufacturing district of Upper Silesia, in Austria-Hungary, and Russia, and has recently been used in the Rhine province and Westphalia for cupola, welding and puddle furnaces, Bessemer converters, on glass houses, sugar, cement, and porcelain factories, in short in all branches of industry where highly fire-proof constructing materia is required.

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Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Chintzes, &c, regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the annual competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1897, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones' "Principles of Design," and the Society's Bronze Medal.

Miscellaneous.

*FOREST FIRES IN NEW JERSEY.**

The question of fires in New Jersey demands mmediate attention. It is the main cause of forest eterioration and its consequences, and of the imoverished condition of a large part of the State of Iew Jersey. There are very few stretches of woodind in this region which have not been thus affected.

The causes of forest fires may be classified as ollows:—(1) Incendiarism; (2) carelessness; (3) parks and hot coals from locomotives; (4) lightning.

The most serious fires are usually those which are purposely set, because set at the proper time and in the proper place. An incendiary bent upon mischief waits until the wood is dry and the wind in the desired direction. There are usually two motives at the back of incendiarism:—(1) Individual gain at the expense of another; (2) revenge.

A few years ago it was not uncommon for colliers to fire a wood in order to buy it cheaply. The charred wood is then only fit for charcoal. Owing to the decline of the charcoal industry and the abundance of charred wood in the forest, this is no longer profitable. Fires were set in meadowy regions to improve the grass for cattle. Savanna lands are still burnt for that purpose, in regions where cattle are turned into the woods. Berry-pickers set fire to huckleberry bushes to improve the berry crop. In a couple of years the young growth which follows bears larger and finer berries. Wood thieves, it is said, set fire to the brush and stumps to hide their tracks. There are many people living in the backwoods of New Jersey who own no woodland, but who gain a livelihood in a variety of ways out of woods which belong to other people. They are mostly berry-pickers, hunters, and wood-choppers.

Fires are set out of spite. If a backwoodsman thinks himself wronged by a woodland owner, he "gets even" by touching a match to his woods. It is certain that for several purposes forest fires are set. Such fires do much damage, and the conviction of such incendiaries is difficult.

Woodland owners, during forest-fire season, feel insecure, expecting a fire at any moment. The incendiary may set a fire to injure an enemy, but the wind may suddenly change, and many others suffer in consequence. Several fires in Atlantic County were set last season in the same region several nights in succession.

Second in importance are fires caused by careless individuals. In clearing land, fires escape from burning brush. A large foreign element has come to South Jersey to clear farms. This increases the danger from fires while the land is being cleared. Tramps, hunters, and boys, with camp-fires, lighted cigars and cigarettes, cause many fires.

Locomotives also are often blamed. It is certain that many fires have been set by sparks from the stack and hot coals from the grate. The greater number of the railroads are using some care. On some roads engineers are cautioned, safety strips are cleared, and, in one instance, furrows have been ploughed along the road, and section-men usually endeavour to put out the fires which are thus caused. If engineers are careful, if the spark-arrester is not withdrawn or poked with holes, if coals are dumped in places prepared for that purpose, and if safety strips are cleared and furrows ploughed along the road, and section men are watchful and willing, there is little danger from that source. It is certain that some railroads are using more precautions at present than woodland owners themselves.

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* Article by John Gifford, Forestry Agent for the Geogical Survey of New Jersey, from *Journal of the Franklin nstitute*, August, 1896.

Although not common, fires have been set by lightning. Certain species and solitary trees are more apt to be struck than others. There are several indications that a disastrous fire was set last summer in South Jersey by lightning, which struck a solitary tree in a field of dry grass.

The effects of fire may be classified as follows:—(1) Destruction of timber and other property; (2) extinction of valuable species; (3) impoverishment of soil; (4) destruction of seeds and game; (5) consequential damage, by affecting industries dependent upon the woods, and by changing moisture, soil, and climatic conditions, which are more or less dependent upon a forest cover.

The amount of damage depends, of course, upon the severity of the fire, which, in turn, depends upon the dryness of the wood, the force of the wind, and the nature of the trees and underbrush.

Often everything above ground is killed. The charred boles of hundreds of trees fall and rot in the woods. In low ground, after a fire, fresh green underbrush soon appears. High land recovers slowly, often remaining bare for many years. There is danger from fires about six months of the year. They are very destructive during the high winds in the spring, when there is little sap in the wood. Dry leaves cover the ground, and many cling to the low oaks.

Certain trees are affected much more than others. This depends mainly upon the nature of the bark. Often, large pine trees appear to be but slightly affected by a ground fire, which burns the underbrush and leaves on the surface. Bark is a non-conductor of heat; but if the cambium, the active part of the tree just beneath the bark is affected, the tree dies. Even then, if it happens in the spring, the tree appears to be recovering. Dormant buds in the trunk sprout, and fresh green leaves are formed.

It is better to cut such trees at once, because they soon die. When the starchy matter in the trunk is exhausted, these sprouts wither and die, the tree is invaded by insects, rots, and topples over. Even a pine log, if cut in the winter, sends out fresh shoots in the spring from dormant eyes. Even if the tree is not itself directly injured, its supply of nutriment and moisture is affected by burning the undergrowth.

The value of underbrush must not be underrated. Although it smothers young trees, it is useful to forests of larger growth. The amount of mineral matter which a tree absorbs is insignificant. Water is the essential element. In checking evaporation and retarding the flow, undergrowth is often necessary. But the smaller amount of dead wood in a forest the better, since it breeds many kinds of insects, some of which may invade the living trees. The material resulting from decay, however, enriches the soil, so that it is better to burn the dead wood which cannot be utilised. In that way the soil is enriched just the same, the insects are disposed of, and the underbrush is not seriously disturbed. It is easy to see, therefore, how fire in a forest is often useful if wholly under control and directed by forester.

In old pine woods, on upland, there is often littl underbrush. The ground is covered with a thin laye of pine leaves.

Stump holes are common in such woods. Whe a pine tree is cut or burnt, the stump decays, and hole of considerable size, with many ramifications, i formed. The ground is often riddled with hole from suppressed trees. These drain the water fro the surface. This, together with the slight shade o pines and lack of underbrush, accounts for the dryness of the soil and atmosphere in pine woods Many trees are soon affected by removing underbrush. The growth of a young oak grove can easil be retarded by trimming the lower limbs and removing the undergrowth.

Since one species is affected more than others, kind of selection continues, which accounts for th peculiar distribution of trees in certain places. Thic bark trees, and trees which produce a vigorous coppice growth, survive the longest. Pitch pines an oaks, therefore, predominate in South Jersey, whil in isolated positions, protected from fires, a grea variety of trees may be found. Certain plants although covered with a thick bark, contain substances in the form of resin, oils, and waxes, whic are inflammable. Others contain substances whic have a tendency to quench fire. The sowing of suc plants along safety lines has been suggested to prevent the slow but destructive ground fires. Th white cedar (*chamæcyparis thyoides*), the mos valuable timber tree in South Jersey, and one of th most valuable in America, although growing in we swamps, is often seriously damaged by fire.

The heat, although it may not burn, is often sufficient to kill the cedar. In unusually dry weathe fires burn for many days in the bed of a swamp. It i is often necessary dig deep trenches in order to chec its headway. It destroys cranberry bogs in a simila fashion. For fear of fires, cedar is cut when fit onl for rails, hop-poles, and laths.

The soil is much impoverished by fire; this is th testimony of a large majority of farmers. The "life" is "cooked" out of it, as they say. The organi matter in the surface soil is often entirely burnt The surface is bared so that the soil is soon completely leached.

Prof. F. H. Storer, in *Agriculture*, says: "With in porous soils nitrates are doubtless formed rathe freely, and, as is well-known, the nitrates are easil washed out from soils, and are liable to go to wast after every rain that is long continued. They are, i fact, leached out of the soil, and the manure fro which they came rapidly wastes away. It is said t be a matter of old and familiar observation in Germany, that in sandy regions, in seasons that are particularly wet, the soil may finally be so thoroughl leached that it becomes unfruitful. When we consider the facts that nitrates are easily washed out o the soil, that they are absolutely essential to plant growth, and that they are continually produced, during the period of growth, from humus, by the action of nitrifying bacteria, we can appreciate the damage to light soils by fire. Land thus damaged needs very careful tillage and green manuring before it can produce a crop of consequence."

When a pine wood twenty years old is destroyed, it may mean many years before the soil recuperates, and seeds are again disseminated. Seeds on the surface are destroyed by fire. Some seeds are seriously affected by slight changes of temperature. Also, many animals are destroyed. In the spring of the year the young are burnt in the nest. It is not uncommon to see many of the smaller animals chased before a fire. By preserving the forest, the animals dependent upon its fruits are preserved.

According to the statements of several seamen, the smoke and fog which the forest fires produce were a serious impediment to navigation along our coast last summer.

The total area burned over in South Jersey during the past season of 1895 amounts to not less than 197,000 acres. No improvement in the forest conditions of a country is possible as long as fires are allowed to burn without any systematic preventive measures. With no protection whatever against incendiaries and individuals guilty of malicious carelessness, the owners of woodland are at the mercy of chance. In consequence, wood is usually cut just as soon as there is a market of any kind. Property in some towns in South Jersey is often endangered. Under such conditions capitalists hesitate to invest in woodland.

If a fire breaks out it is seldom noticed until it has attained considerable size. The owner of the land coaxes and lures a few men to help him fight it. A fire often burns for some time, owing to the fact that competent men cannot be found. Many refuse to fight in the daytime. They wait until evening, when the fire is smouldering. Many fighters do more harm than good. These men are generally not paid. Often they are allowed to cut the dead wood. When this is refused the landowner is considered mean, and often has difficulty afterward in finding fighters. When allowed to cut dead wood, the privilege is usually abused. When a fire once gains headway in a dry woods, propelled by a strong wind, it is difficult if not impossible to check. Such work requires brave, skilful men, familiar with the region, and not chance men picked up here and there. The rapidity of spread of the fire depends, of course, upon the condition of the woods, and the strength of the wind.

Although these fires are rapid, and although the sparks may fly long distances, a stream, spur of swamp, or even a road, are often sufficient to check their headway. Many fires which are very destructive urn for some time without being noticed.

The method of fighting is by back-firing. After the wind and other conditions have been noted, a party goes ahead to a road, which is always an excellent point of vantage, and burns back towards the fire. If possible, furrows are ploughed. The fires meet, and the force of the main body of fire is checked or diverted. Back-firing on another man's property to save your own often causes trouble.

This much is certain about fires in South Jersey, that back-firing, in the proper way is the most practical method of checking a fire, and that roads are excellent points of vantage. The clearing of roads for some distance on each side, and the burning of safety strips at the proper season, are important steps toward the prevention of fires. Were large tracts of woodland divided into sections, and each section surrounded by fire lines, there would be less danger. South Jersey is such a mass of woods, that when fire once gains headway, it travels for miles without meeting with opposition. Fires can be much more easily controlled in South Jersey than in a mountainous region. Sand, which is excellent material to fight with, is fortunately plentiful.

Proper policing by a mounted, organised, well-directed force of wardens is necessary. The territory must be divided into districts of a certain size, irrespective of political divisions, with a warden to each district, with the wood, road, and clearings of which he must become perfectly familiar. He must be held responsible for that district. Stationed on an eminence, with field glasses, one man can control a large area in South Jersey. It must be his duty to enforce regulations, and to apprehend and bring to court all offenders. It must be his duty to keep a strict record of fires and other facts concerning the forests of his district. With a corps of twenty-five brave, skilful men, organised and under one head, fires can be reduced to a minimum, if not altogether stopped in the southern interior of New Jersey. These wardens must have the power to call on men to help them when necessary. These men must be under his control, and be paid fair wages for their work. Fighting fire is such a disagreeable and laborious task that there is little wonder competent men who will work for nothing are difficult to find. Experience in other countries show that the presence of wardens has a strong educational influence. Twenty-five good men, for six months of the year could be procured for $500 each. Allowing as much much more for other expenses, $25,000 would cover the cost of such a force. Considering the damage during the past season, there is economy in such a measure.

The prevention of fires is a difficult matter. It can be accomplished only by the co-operation of railroads, a large majority of the woodland owners, and public-spirited citizens, coupled with the aid of the proper kind of laws, backed with ample means for their enforcement.

To sum it all up, fires can be reduced to a minimum by removing the causes. Many of these causes are avoidable, and will not exist if there is the proper kind of laws, with ample machinery for their enforcement. The few fires which are unavoidable can be extinguished in their incipiency if there is a warden present who knows just what to do and how to do it.

PRODUCTION OF TUSCAN OIL.

The olive tree forms one of the chief agricultural resources of Tuscany. It is estimated that about 270,000 acres are devoted to its cultivation, and that an average crop of olives yields about 6,700,000 gallons of oil. Tuscan olive oil is essentially a high-class food product, and when obtainable from sound well-matured fruit, with due skill and attention devoted to the process of extraction, as well as suitable appliances, it reaches the very highest standard of excellence, and cannot be surpassed by the product of any other country. This pre-eminence is fully recognised in an elaborate report upon agriculture in Italy, issued by the Italian Department of Agriculture, Industry, and Commerce, where, in treating of olive oil, it is stated that "the Tuscan oil of Lucca, Calci, and Buti, is considered to be the finest in the world." That this, says the United States Consul at Leghorn, is no vain boast, is evidenced by the fact that whenever the genuine product of Tuscany appears on a foreign market, it very soon takes the first place as a table oil, distancing all competitors, where quality is the consideration, by its superior merit. Though more generally known out of Italy as "Lucca oil," the production of the finest oil is by no means limited to the province of that name, but extends also to the adjoining province of Pisa, and to a few outlying districts adjacent to both provinces. Thus Calci and Buti, mentioned in the report quoted from above, are both situated in the province of Pisa. The olive groves which clothe the hills extending from Viareggio to Genoa, on the Genoa-Pisa railway, and from Pisa to Pontedra, on the Leghorn and Florence line, are famed for the oil they produce. The conditions which govern the production of olive oil of the highest grade, *i.e.*, oil possessing a delicate flavour, fine light golden colour, of medium density, and possessing good keeping qualities—and speaking only here of conditions due to nature as distinguished from those which depend merely upon the mechanical treatment of the fruit—arise from (1) the nature of the soil, (2) the topographical situation of the olive groves, (3) the climate, and (4) the species of olive tree cultivated. In Tuscany the finest oil is produced by the olive groves situated on the slopes of hills, with a suitable exposure and a subsoil of a rocky nature, preferably calcareous, or also with some admixture of silicious matter, and from a particular variety of the olive tree. But the same class of trees, if growing on the richer soil of the plain where there is necessarily greater moisture, will not produce the same quality of oil. The tree, indeed, will vegetate more luxuriously, but oil yielded by its fruit, which will ripen sooner than on the hills, will be heavier, destitute of fine flavour, and more highly coloured—altogether an inferior article. Climate has also much to do with the quality of olive oil; certain varieties of the olive flourish in hot climates, such as Sicily, Tunis, and Asia Minor possess, where the trees grow to a great size; but the oil they yield is gross, heavy, of unpleasant taste, even when made with th greatest care, and disposed to turn rancid almost immediately. A climate warm in summer, but strictly temperate, like that of Tuscany, suits the oliv tree admirably, while the moderate cold experienced during the winter is also beneficial, as it tends to ki off parasitic growths and insects that prey on the tre or its fruit. There is no variety of the olive tree that can equal the Razzo olive in regard to the quality of the oil produced, and this variety is preferred to all others in the provinces of Lucca and Pisa, where the finest oil is obtained. But it thrives only on the slopes of hills where there is a subsoil of a rocky nature and no excess of moisture. The Razzo olive tree attains a goodly size in the course of years, and is very different in this respect from the common olive tree, which has generally a stunted appearance. Its leaves also are larger and less pointed, and of a darker shade of colour. The fruit is of fair size, but equally removed from the small, rather pointed, berry-like common olive as from the large fruit of the olive tree of the south, of which the Spanish olive is a type. In fact, the Razzo olive occupies an intermediate position between the latter and the hardier kinds above mentioned. In full bearing an acre of olives will produce on an average about 64 gallons of oil a year. One year the quantity may be very much greater, but the following year, after a full crop, the trees will probably bear little or no fruit. The olive blossoms in April or May, according to the season. In October the olives begin to change colour from green to purple-black, and to carry oil; but maturity is not reached, even in the case of the fruit most advanced (since all the olives on a tree do not ripen simultaneously), until December; the later fruit may not mature until May or even June. Oil made early in December is rather dark coloured, peppery and biting to the palate, the fruit not being sufficiently ripe. From the beginning of the year to March, oil of perfect quality is made, tasting of the fruit, but delicate and soft, with a fine, light golden colour. Thence on, the fruit gets over ripe; oil of a very pale colour is obtained at times, of a milky shade, sweet tasting, but wanting in distinct flavour, and liable to turn rancid very soon. The practice in the best olive districts of Tuscany—that is where the olive trees are planted in groves to the exclusion of all other trees or crops—is to gather the fruit day by day as it drops from the tree on to the grass beneath. To strip the trees by hand would be a gigantic task, and would moreover involve plucking ripe and unripe fruit, since with a great number of trees the stripping could not be repeated as the fruit ripened, but when the fruit is ripe, by shaking the branches it can be made to fall to the ground on cloths stretched below.

The harvesting of the olive crop calls for an abundant supply of labour. The fruit as it falls or is shaken off the trees must be gathered in immediately, and crushed and pressed, otherwise it will suffer rapid deterioration, with the consequence that the oil made from it will be bad. The fruit when taken to the *frantojo*, or mill, is hand-picked, and all unsound berries removed. It is then crushed in the mill with as little delay as possible. The olive mill has the form of a circular trough, built of cut stone, in which there revolves a perpendicular millstone. Iron in the composition of the mill is avoided as it communicates a bad taste to the oil. When the olives are reduced to a uniform pasty mass (no water whatever is added during the grinding), the latter is transferred to bags made of a kind of tough flexible reed. A number of these bags when filled are placed in a pile under the press. On pressure being applied, the oil streams forth and is collected in a receptacle just under the press. It has been found that when an iron frame has been substituted for the reed bags (as practised with seed oils), the oil acquires a bad taste, hence the more primitive method of the bags is adhered to, the material being invariably reed, horsehair or other animal hair being objectionable as communicating a bad odour. The first pressing, without any addition of water to the olive pulp, alone yields high-grade oil; it is termed *olio di polpa*, or pulp oil, to distinguish it from the oil obtained from subsequent pressings of the residue, which latter is termed *olio di sansa*, or residue oil. The *sansa*, on being passed through the mill again with the addition of a mixture of hot water, and then pressed, yields an inferior kind of oil. Even after the second pressing the residue still contains a small proportion af oil, which is only fit for soap-making and other industrial uses. The pulp oil as it comes from the press is called "must oil." It requires no further treatment than clarification, which is best effected by passing the oil through special filters, disposed in rows one above the other, and in which the filtering medium is cotton wool, which, however, must be carded. When clarified it is kept in masonry tanks lined with marble and covered over. Cool storage is essential, as too high a temperature deterioates olive oil, hence it may be added that bottled oil should be kept in a cool place, and on no account exposed to the direct rays of the sun. High-class olive oil can only be obtained from perfectly sound, well matured fruit, crushed and pressed without any delay as soon as it has been gathered. Damaged fruit, or even fruit originally sound, but which through delay in crushing has been fermented, will produce inferior oil. It is necessary to add that the condition of the olive crop depends greatly upon favourable weather during the winter, when it is approaching maturity. Dry cold, or even a touch of frost, provided it be neither severe nor prolonged, is not injurious to the fruit; but a sharp frost ensuing upon a fall of rain or snow, when the fruit is still wet, will entirely ruin it. Frostbitten olives produce a dark-coloured, bad-tasting oil, and the yield is diminished. Tuscany, adds Consul Rosenthal, produces olive oil of insuperable quality, but not all the oil produced in Tuscany itself answers this description. Hence, really fine "Lucca oil" always commands a good price, while much of the olive oil sold and described as such, but not vouched for by a firm of good standing and high repute in the export trade, is at least a mixture of inferior Tuscan oil with a still cheaper and inferior growth of the Bari district in south-east Italy, if indeed not exclusively the latter; for, strange though it may appear, a considerable quantity of olive oil is brought every year from Bari to Leghorn, Lucca, and other markets in Tuscany, and much of it is re-exported under the guise of "Lucca oil." There is much adulteration of olive oil with seed oil, chiefly cotton seed as being the cheapest of all, but it does not pay to adulterate fine Lucca oil, for the quality would be ruined, and the mixture would acquire the taste of the cotton-seed oil or other adulterant. This will explain, says the Consul, what is an undeniable fact, that no really fine Lucca oil is ever, under any circumstances, anything but strictly pure olive oil. The cheapest kind of olive oil (common olive oil) is the only kind that is ever adulterated, its original quality being so bad that any further deterioration becomes a matter of impossibility. Common oil is in large supply. Italy alone produces on an average about 90,000,000 gallons of olive oil a year, and of this a large proportion is common, or at least very inferior, oil.

THE MINERAL PRODUCTION OF CALIFORNIA.

The State Mining Bureau of California has just issued, in tabular form, a statement, showing the mineral production of the State for the year 1895. The statement shows that the value of the total mineral product of California in that year was 22,844,664 dollars, as compared with 20,203,294 dollars in 1894, an increase of 2,641,370 dollars, a considerable part of which was due to the greater production of gold. Gold is by far the most important single interest in the State, and the mining of silver holds quite a subordinate place. No silver mines of any size are found outside the calico district in San Bernandino county, which produce a little over one-third of the total silver reported. Next in importance to the precious metals is quicksilver. The mines of that metal are still very actively worked, and show a substantial gain over 1894. Napa, Santa Clara, and Trinity counties are the leaders in this production, and nearly all the mines of the State were in active operation last year, although no new discoveries were made. The other products include chrome ore, which was one of the few industries showing a diminished output; antimony, of which a small amount was obtained from the mines in Kern county; lead from Inyo and Mono counties; copper from Amador, Calaveras, and Nevada counties, chiefly obtained in connection with the gold mines; manganese ore and platinum. Of the latter metal 150 ounces are reported. The non-metallic substances which are of considerable importance, comprise borax, coal, salt, asbestos, gypsum, magnesite, and soda. California is not rich in mineral fuels, and the only coal supply obtained within the State, with the exception of a few thousand tons from southern California, is from the Mount Diablo and Ione mines, which last year furnished about 70,000 tons. The third division of the report of the bureau includes the hydrocarbons and gases. The production of petroleum in California has increased very considerably, the discovery of new oil territory in and around Los Angeles some two years ago having been utilised by the boring of numerous wells, so that the district is now actively worked. Asphalt and bituminous rock are mined in increasing quantities, as the value of the California product is recognised. The fourth, and final division, of the report is devoted to structural materials, in which are included the product of the quarries of various kinds of stone, the cement, the bricks, and other materials made from clay and lime. California is well supplied with building stones of varying qualities, especially of the finer kind, such as granite and marble; while onyx has been found in some localities, and is quarried on an increasing scale. The State is also well furnished with lime and materials for the manufacture of cement, and supplies nearly all tho home demands.

THE FISHERIES OF NEW ZEALAND.

New Zealand fish resemble those which are found on the coast between Madeira and the Bay of Biscay more than those caught about the shores of Great Britain. Of the sea fish that are used as food in New Zealand, there are the hapuka, tarakihi, trevally, moki, aua, rock cod, wrasse, and patiki, and while the trumpeter, butterfish, and red cod are confined to the south, the snapper, mullet, and gurnet are met with only in the north. With the exception of the patiki or flounder and the red cod, none of these, according to a report by Sir James Hector in the "New Zealand Official Year-book," represent fishes common even in the south of England, while from the more northern seas similar fish are altogether absent. In addition to those which remain throughout the year, a very large number of the fish of the New Zealand coast, owing to its geographical position, are pelagic in their habits, and roam over a wide range of ocean, visiting the shores only irregularly in pursuit of food. Of the edible fish of this class, by far the largest number are visitors from warmer latitudes, such as the frostfish, barracouta, horse mackerel, kingfish, dory, warehou, mackerel, and garfish, while of more southern types only the ling, hake, haddock, and a few others, rare and worthless as food, reach as far as the New Zealand coast in their migrations. Of 142 species of fish enumerated as found in New Zealand, 67 are, as far as is known, peculiar to New Zealand; 75 are common to the coasts of Australia or Tasmania; while 10 species are found in New Zealand and other places, but not in the Australian seas. The following is a list of the fishes which are chiefly met with in the market:—Hapuka, red snapper, tarakihi, moki, trumpeter, frostfish, barracouta, horse mackerel, trevally, kingfish, warehou, mackerel, rock cod, gurnard, mullet, haddock, butterfish, red cod, whiting, ling, flounder or patiki, sole, garfish, grayling, smelt, kokopu, sardine, sprat, eel (tuna), black eel, conger eel, and silver eel. A considerable industry has sprung up of recent years in canning and preserving fish. The fish principally used for canning is the mullet, which is caught in large quantities in the Auckland district. The total value of fish exported in 1894 (potted, preserved, dried, pickled, salted, and frozen) amounted to £6,228. Oysters exist in considerable quantities, the rock oyster being found in the Auckland district, the deep sea oyster principally in Foveaux Strait, where the process of dredging for them gives employment to a number of small vessels. At the census of 1891 returns were received from 253 fishing industries, employing 667 persons. The boats used amounted to 418 in number, and 788 tons; 1,340 nets were in use. For oyster dredging, 13 boats and 22 dredges were employed. The fur seal is found on the islands near the coast of New Zealand, but may not now be killed. The sperm whale is found in the region of the ocean lying to the north-east of the colony. The harbours of New Zealand were formerly visited by whalers for the purpose of refitting, carrying on shore fishing, and barrelling the oil. The industry is not a large one at the present time, being carried on only by a few persons.

HAMBURG HORTICULTURAL EXHIBITION, 1897.

The Department of Science and Art has received, through the Foreign-office, a translation of a note from the German Ambassador in London, announcing that an International Garden Exhibition will be opened at the beginning of May next, and close at the end of September. The Exhibition is intended to show all branches of gardening and the cultivation of all kinds of plants; and it is proposed to make it the most extensive and important exhibition of gardening ever held.

The Horticultural Society of Hamburg, Altona, and surrounding districts having arranged to hold a Horticultural Exhibition for the celebration of their sixtieth anniversary in 1897, a committee was constituted on December 16th, 1895, at the Society's suggestion, to prepare and take charge of the General Horticultural Exhibition in Hamburg, 1897. The Burgomaster of Hamburg, Dr. J. G. Mönckeberg, has accepted the presidency of this committee. Hamburg citizens have raised a guarantee fund, amounting to half a million marks, thus securing the undertaking. The free city of Hamburg has placed the beautiful park between the Holsten- and Millern-gate, tuated in the centre of the city, at the disposal of the ımmittee, and further assistance from the authorities :pected.

The Exhibition will represent every branch of ɔrticulture, arboriculture, and floriculture, and will be ɔen to every gardener and friend of horticulture, ithout regard to nationality. Workmen, merchants, ıd artists, who manipulate products of horticulture, whose manufactures or preparations are in any re- tion to horticulture, are also invited.

The committee proposes:—(1) A Permanent xhibition, out of doors and under cover, from the ginning of May, 1897, to the end of September, 897; (2) a Spring Exhibition, from May 1st until lay 7th, 1897; (3) a Special Exhibition of plants, owers, and vegetables, from May 30th until June rd, 1897; (4) a Special Exhibition of plants, flowers, nd shrubs from July 2nd until July 6th, 1897; (5) a pecial Exhibition of plants, flowers, and fruits of ıe season, from July 30th until August 3rd, 1897;) a general Autumn Exhibition, from August 27th ntil September 5th, 1897; (7) a general Fruit xhibition, from September 17th until September ɔth, 1897.

In addition to those offered for the special compe- tions, other prizes will be awarded for flowers, fruit, ıd vegetables, which at the time of exhibition are at ıll growth and maturity: 300 gold medals, 2,600 lver medals, and about 30,000 marks in cash will be iven in the competitions.

Copies of the complete programme can be obtained om the Committee of the General Horticultural xhibition, Hamburg (Gr. Reichen, Str. 5).

'OST-OFFICE MONEY ORDER SERVICE.

The following historical account of the system of ansmission of money by postal and telegraphic rders is taken from the forty-second annual report f the Postmaster-General:—

The money order system of the Post-office is rather ıore than a century old.

In the year 1791, when the Postmasters-General 'ere anxious to find some means of checking the equent thefts of letters containing money, Mr. osnell, an accountant of Crutched Friars, proposed vo schemes for adoption by the Post-office, one of ıem being somewhat similar to the money order 'stem of the present day. The Postmasters-General ıd the staff of the Post-office were favourable to its loption, but the legal advisers of the Department oubted whether the Postmasters-General, even with ıe concurrence of the Treasury, had power to adopt , and it was eventually decided that the scheme ıould not be officially taken up.

Six officers of the Post-office, however, called the clerks of the roads," who were already conducting large newspaper business for their own advantage, ıme forward with a proposal to undertake a money order plan, or, as it was then called, a "money letter" plan, and the Postmasters-General not only sanctioned and encouraged the venture but also bore the cost of advertising it; and, after some hesitation, allowed the advices of the money orders to go free by by post under the "frank" of the Secretary to the Post-office.

The scheme came into actual operation on the 1st October, 1792. The limit of an order (which appears, however, to have been frequently transgressed) was £5 5s., and the commission charged (of which the payee of the order paid 3s.) was at first 6d. in the pound; it was reduced on the 1st January, 1793, to 4d., for orders to or from London, while it remained at 6d. between country towns, and subsequently reached the sum of 8d. in the pound for all orders,* the commission being in addition to stamp duty.

In 1793 a suggestion was made to raise the limit of each order to £20, but this was not carried into effect.

From the 1st January, 1793, the whole commission was paid by the remitter, and he was charged in addition, not only stamp duty, but also the higher postage of double letters, each packet of course containing both a letter and a money order. This hardship was so severely felt that, in 1827 for Ireland, and in 1837 for Great Britain, the orders were printed at the top of a large sheet of paper on which a letter might be written, so that the whole might pass for a single postage. It appears that, in the earliest days of the Money Order-office, this had sometimes been done without authority.

The capital embarked originally in the Money Order-office by the "clerks of the roads" seems to have been about £1,000.

On the 5th April, 1798, the "clerks of the roads" gave up the scheme, which had left them with a loss of £298, besides interest; but the senior of them, Mr. Barnes, invited Mr. Daniel Stow (superintending president of the inland office) and Mr. Slater to join him in carrying on the Money Order-office as a private speculation. Other partners joined from time to time, and when the Committee of Revenue Enquiry reported upon the Post-office in 1829, the Money Order-office was being carried on by Messrs. Stow and Watts. The committee disapproved of such a concern being carried on by private persons for their own profit, and they recommended that, if it were continued, it should be officially controlled, and the produce be appropriated to the revenue. Accordingly, to prevent the creation of any new vested interests, no new partners were allowed to be admitted, and the death of Mr. Stow, in 1836, left Mr. Watts sole proprietor, with a capital embarked in the concern of £2,000. Unfortunately, however, a similar interest has been created in Ireland, a Money Order-office having been given to Mr. Lees in 1831 (on a re-organisation of the Irish Post-office) in exchange for a clerkship of the Munster-road which he surrendered.

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* It appears that, in 1838, orders under 10s. were being issued for 6d., but it is not clear whether this was or was not in accordance with the general rule of the Money Order-office.

The Government determined, in 1831, to undertake the money order business, and to compensate these two officers. Mr. Watts received more than £400 a year, and Mr. Lees more than £500 a year, and business was commenced by the Postmaster-General on the 6th December, 1838. The rates of commission were—for orders not exceeding £2, 6d.; £5, 1s. 6d. The number of orders issued in 1839 was 188,000. In November of the following year the rates were reduced to—orders not exceeding £2, 3d.; £5, 6d.; and the number issued rose to 587,000 in 1840, and 1,500,000 in 1841. The average number of orders annually issued for the next succeeding years was as follows:—1842–46, 3 millions; 1847–51, 4½ millions; 1852–56, 5½ millions; 1857–61, 7 millions.

At the beginning of 1862 a change was made by allowing the issue of orders for larger sums; the existing rates were not altered, but orders were issued for sums not exceeding £7, 9d.; £10, 1s. The annual numbers issued were—1862–66, 8 millions; 1867–70, 9¾ millions. On the 1st May, 1871, a further reduction was made.

As a consequence of this reduction the number of orders issued rose, in 1871, to 12 millions; from 1872 to 1876–77 the average was nearly 16 millions; and in 1877–78 the highest number ever attained, viz., 18 millions, was reached.

It was found, however, that the low rate of 1d. for orders under 10s. did not provide a profit, and it was therefore decided to raise the rate of commission for the smaller orders, and to provide a cheaper means of remittance for small sums.

The rates were raised on the 1st January, 1878, to —orders under 10s., 2d.; orders under £2, 3d., and, at the same time, the charge for registration of letters was reduced from 4d. to 2d. The rest of the scheme was realised by the introduction of postal orders on the 1st January, 1881.

The average annual number of money orders issued from 1878–79 to 1880-81 was nearly 17 millions, and the average numbers between 1881–82 and 1885–86 were 13 millions.

On the 1st September, 1886, the rates were altered to those now in force.

The average annual numbers have been—1886–87 to 1890–91, 9 millions; 1892–93 to 1895–96, 10 millions.

Greatly, however, as the number of money orders has fallen off since the year 1877–78, the amount of money transmitted thereby has actually increased, for the sum in 1877–78 was £27,870,117, and in the past year has been £29,726,817.

In addition to the ordinary service for the public, money orders are largely for pensions and other payments by the Government offices. In the past year the number of such orders has been 1,754, 3, representing £6,037,399.

In the year 1843 Sir Rowland Hill includ a money order system with the Colonies in a lis of improvements which he wished to introduce, it no active steps were taken in the matter il 1849.

In 1867 an English money order - office as established in the Paris Exhibition, and about 4 o orders passed each way. In 1868 the first M y Order Convention was concluded with a for n power, viz., Switzerland; the orders between e two countries were first issued on the 1st Janu y, 1869, and the rate of commission was the sam as that for inland orders.

On the 1st of July, 1869, money orders bega o be exchanged on the same terms with Belgium, it in 1871 the rates for these two countries were ra d to threefold the inland rates. On the 1st Janu , 1880, the rates for colonial money orders were red d to the same level, all foreign and colonial mo y order rates being thus assimilated. On the st January, 1883, the rates were further reduced to e present scale.

There are now few countries in the world h which this country does not exchange money ord ; and the British Post-office also acts as a medium r the exchange of money orders between several fore n countries and British colonies which have no mo y order arrangements with each other.

On the 2nd September, 1889, the issue of t - graphic money orders between London and 17 la e towns was commenced as an experiment. Betw n that date and the 28th February, 1890, 2,088 or s were issued, of the value of £8,674. On the t March, 1890, it was extended to all money o r offices, which were also telegraph offices.

The number of telegraphic orders issued has b n approximately as follows:—1890–91, 30,000; 18 - 92, 42,0 0; 1892–93, 80,000; 1893–94, 107,0 ; 1894–95, 132,000; 1895–96, 153,000. The aver e amount of a telegraphic money order during the t year has been £3 7s. 2d.

Postal orders were first issued on the 1st Janu , 1881.

FAILURE OF THAMES WATER.

The following curious particulars respecting - stances of the running dry of the Thames, from e year 1114 to 1716 A.D., are taken from an articl n Symons's Meteorological Magazine:—

1114.—"This year there was so great an ebb eve - where in one day as no man remembered before, that men went through the Thames, both riding l walking, east of [i.e. below] London Bridge.—Ang-Saxon Chronicle, Bohn's edition, 1847, p. 484.

1114.—April 4th. River Thames in London dry that children waded over between the brid, nd the town. Under London Bridge only knee eep; was dry for two days.—*Stow.*

1114.—October 10th. The Thames on that day uffered a great want of water; for between the ridge [*i.e.* London Bridge] and the royal Tower, and ven under the bridge, the water of the bridge was o diminished, that not only horses, but also an inumerable crowd of men and boys walked through it, e water hardly reaching their knees. This shortness f water lasted from the middle of the preceding ight till the full darkness of the following night.—*lorence of Worcester.*

1114.—Such a defect of water in the Thames that reat numbers of people crossed not only above and elow London Bridge, but likewise through several f its arches, upon the ground, with dry feet.—*aitland's History of London.*

1158.—An earthquake happened in many places hrough England, and the River of Thames was ryed uppe, that at London men might walke over he same dryshod.—*Stow's Annals*, 1615.

1281.—So great a drought that men passed over he River Thames dryshod between Westminster and ambeth, and over the Medway between Strood and ochester.—*Stow.*

1541.—A remarkable drought; almost all the mall rivers dried up, and the River Trent diminished o a straggling brook. The River Thames so low hat the sea water even at ebb, extended beyond ondon Bridge.—*E. J. Lowe's Natural Phenomena & Chronology of the Seasons*, 1870, p. 18.

1591.—The Thames, historians say, was so dryed p, that a man might ride over it on horseback ear London Bridge.—*Thoresby.*

1592.—September 5th. One standing on the shore f the Thames could not see any water in it from ondon Bridge to Westminster.—*Stow* [See quota-on in full under date of 1716, Sept. 14th].

1687.—May 12. This day there was such a storm f wind as had seldom happened, being a sort of urricane. It kept the flood out of the Thames so hat people went on foot over several places above ridge.—*Evelyn* in *Baker's Seasons.*

1716.—September 14th. This being the last occaion, we have taken some pains to collect corroboraive evidence as well as direct statements, and ave quoted repetitions where any fresh fact is menioned :—

DEAL.—September 14th. "Last night we had a iolent storm at S.W., which drove several ships om their anchors."—*The Post Man*, No. 11520, eptember 15th to 18th, 1716.

YARMOUTH.—"Last night we had a violent storm, hich drove from their anchors several vessels."—*dem.*

LONDON.—"So violently tempestuous was this orm that it obstructed the coming up of the tide in e River of Thames, which was even driven to so w an ebb, that both above and below the bridge, people passed and repassed on the sands, which lay so clearly bare to view that a silver tankard, a silver-hilted sword, a gold ring, a guinea, and several other things were taken up that had been lost there."—*The Weekly Packet*, No. 220, September 15th to September 22nd, 1716.

1716.—September 14th. And, in speaking of this, it ought to be taken notice that this river has several times been blown almost dry, so that one on the shore could not see anything from London Bridge to Westminster, particularly on the 5th of September, 1592, and again on the 14th of September, 1716; of the last I was an eye-witness. The springs being then low, a strong westerly wind that had blown all that day and the preceding night prevented the tide coming in 24 hours, and drove forward the fresh water with that fury that there was only a narrow channel in the middle scare ten yards wide, and so shallow that thousands of people passed over it on foot.—*Survey of London and Westminster*, by J. Stow, edited by J. Strype, 1754, vol. I., p. 58.

1716.—[Date not given; context shows that it refers to 1716, 1717, or 1718; and therefore it doubtless was September 14th, 1716, *i.e.*, the same as the preceding.] By a long and dry season, the fresh stream of the river Thames was reduced so low that, by the intervention of a violent storm of wind at west south west, it was blown so dry, that many thousands of people passed it on foot, both above and below London Bridge, and through most of the arches.—*History of London, by W. Maitland, F.R.S.*, 1775, p. 521.

1716.—September 14th. The Thames lay perfectly dry, both above and below bridge, leaving only a very narrow channel, which extraordinary circumstance was occasioned by a strong westerly wind, that blew all the preceding day and night, which forced back the tide, and drove forward the ebbing waters.—*Boyle's Universal Chronology*, 1826, vol. ii., p. 748.

1716.—"In the year 1716 a very remarkable phenomenon occurred at London Bridge, when, in consequence of the long drought, the stream of the River Thames was reduced so low, and, from the effect of a violent gale of wind at W.S.W., was blown so dry, that many thousands of people passed it on foot, both above and below the bridge, and through most of the arches. Strype, in his edition of Stow's *Survey*, vol. I., p. 58, states that he was an eye-witness to this event, and observes that, on September 14th, the channel in the middle of the river was scarcely ten yards wide, and very shallow, the violence of the wind having prevented the tide from coming up for the space of four and twenty hours. Whilst the Thames remained in this state, many interesting observations were made on the construction and foundation of London Bridge."—*Chronicles of London Bridge*, p. 482-3, by Antiquary, London, 1827.

THE RESOURCES OF MADAGASCAR.

A correspondent of the French *Monde Economique* says that the President of the Republic has recently signed a decree regulating the working of gold, precious metals, and precious stones in Madagascar. This decree guarantees to gold seekers and miners the rights of their discoveries and the fruits of their labours. The nature and importance of the gold fields are, it is said, well known; all that is required is capital to work the immense wealth that underlies the soil. After Australia and Borneo, Madagascar is the largest island in the world. It has an area of 600,000 square kilometres, and it is remarkable for its geographical configuration, and its fauna and flora. The interior of the island is a compact mass of extinct volcanoes, and of mountains which slope down to the sea. There are virgin forests, which form a belt between the coast and the mountains. The coast is, as a rule, swampy and unhealthy, and this is in great measure caused by a large number of streams which water Madagascar, and which form a vast marsh in their course. These streams, when once embanked, could well be utilised for trade and industry. The Bay of Diego Suarez, called the citadel of the Indian Ocean, comprises four ports, and might become the finest anchorage in the world. All the fleets of the world might anchor there easily, and military, naval, and commercial establishments might be founded there. The roadstead is safe and well situated, a magnificent basin, 10 kilometres long and 7 kilometres wide, with a depth of from 20 to 50 metres, with a sandy bottom, occupies the centre of it. It is in the plains of Tsianaka and Imerina that the finest pasturages are found, and these extend for a length of 400 kilometres. This is the healthiest and the most sparsely populated part of Madagascar. Towards the south there is a vast region still unexplored. As far as can be estimated, there are 4,000,000 of people, of whom 1,500,000 are Hovas, and therefore labour would be by no means scarce to develop the resources of the country. Accustomed to hard work, and used to the climate, to a very spare diet, and to the pestilential exhalations of the swamps, the natives are eminently fitted for manual labour. Europeans pay them at the rate of about 6d. a day for their work. The soil is so fertile that everything grows there. Tobacco, cacao, vanilla, spices, maize, tapioca, the castor bean, and ground nuts abound. There is an abundance of india-rubber trees in all the forests, but owing to the rude method of collecting the sap, many are destroyed. The littoral of the east of Madagascar is specially suitable for the cultivation of vanilla, and capital and skilled labour are alone required to develop this industry. A native flax is cultivated in the south-east provinces. Orchilla is collected on the west coast of the island, and it is said that the vine could be cultivated with advantage in Madagascar. At present both wheat and wine are imported from France. There is another plant which could well be grown in Madagascar, and that is the tea plant. The forests abound in tim r, which is useful for building purposes and cabi - making—ebony, *lignum vitæ*, teak wood, sa al wood, and *nato* wood are found in profusion. Eb y is sold at about 200 or 275 francs (£8 to £11) e ton. The mineral wealth of the island rem is almost unexplored, but it is rich in metals, and d certainly exists in considerable quantities. Som of the precious stones are also found, and pearls e discovered in some of the bays. A species of anthracite coal is found in the north-west of Madagascar, and is seen cropping up in some of the river banks. There are coal mines in abu - ance. One of these fields has an extent of 111 m s in length and 25 miles in width, it is not far from e coast, and thousands of tons of coal of a quality e l to the best Welsh can be obtained from it. Pe - leum springs are found nearly on the surface of e soil. Iron is abundant, and tin, copper, antimo , rock crystal, and bitumen are found almost ev - where on the island.

PRODUCTION OF CITRATE OF LIME I ITALY.

Citrate of lime, which seems to be the safest fo in which the acid principle can be conveyed, an s the substance whence the citric acid is directly ma - factured, is now prepared in Italy, although up within the last quarter of a century this prelimin process was considered impracticable from a remun - ative point of view. A well-known authority Italy writing on this subject, laments in forci terms, says Vice-Consul Pignatorre, the remissn and ignorance of his countrymen in Sicily, wh alone permit foreigners to reap that harvest wh Italians neglect to gather and garner for themselv The objections raised in bygone days from the su posed impossibility of procuring at home a suffici quantity of proper chalk, have been shown to utterly mistaken with respect to the production citrate of lime. Objections of a similar nature are n mooted with regard to the production of citric ac and have been partially disproved already by establishment of a British firm in Messina, wh has undertaken successfully the manufacture of cit acid in conjunction with tartaric acid. The theory the chemical process for compounding citrate of li is simple enough, the commercial value of the su stance, however, depends greatly on the purity a good quality of the chalk employed. The Cre Inglese, or Craie de Meudon, were, until very late considered not only the best sort of chalk for t purpose, but the only suitable kind, and were e clusively used in those rare and exceptional cases which citrate of lime was made, rather as an expe ment than as a practical speculation. The exclusiv ness enjoyed by English or French chalk has be broken through of late years, and the adaptabili

Italian chalk recognised very generally in
manufacture of citrate of lime which is
y undertaken successfully in many parts of
thern Italy, although it is considered by some to
of very inferior quality to that made elsewhere.
e process of manufacture is as follows. The raw
e of inferior lemons (*i.e.*, lemons which could not
exported as green fruit) is mixed at a temperature
80 degrees with sufficient whiting to form a paste,
erein all the acidity of the lemons has been
sorbed by the whiting. This paste is then placed
stout canvas bags which are piled up and sub-
ted to great pressure to extract the valueless liquid
t, all the essential properties of the lemon juice
ng retained in the chalk. The substance thus
ained is next spread out in tiers in drying cham-
rs, artificially heated, until it crumbles away into
wder, which is the citrate of lime as known in com-
rce. This is generally shipped in tierces contain-
g about ten hundredweights. From this composi-
n, by a very simple operation is obtained citric
id, by pouring upon the citrate of lime sufficient
ute sulphuric acid, nine ounces being generally
out what is required for each ounce of "chalk."
e fluid thus obtained is strained through a cloth
ainer and exposed in shallow enamelled pans, so
at it may crystallise by spontaneous evaporation.
e ounce of the citric acid crystals thus obtained
about equal to a pint of lemon juice. Two
ousand lemons should yield about eighty kilo-
ammes of citrate of lime and eight ounces
citric acid should be obtained for every
perial gallon of raw lemon juice treated as
ove. Citric acid, which is a most valuable
bstance from the many and various uses to
hich it may be applied, is then the concentrated
id principle of the juice of the lemon, orange,
d citron, but more particularly of the former
d it has, strange to say, been manufactured
ly of late, and on a very limited scale, in
e land which produces all the raw material for
preparation, except perhaps, to a certain ex-
nt, the combustible employed, which from the
arcity of wood and absence of coal has
cessarily to be imported, in a good measure, from
reign lands. As a matter of fact, up to quite
cently the very idea of making citric acid in Italy
as scouted, and is now only manufactured in small
antities by one or two firms, notably by the firm of
veline Bros., who produce at Messina considerable
antities of citric acid, in conjunction with tartaric
d even sulphuric acids. Nevertheless there seems
be no valid reason why this industry should not be
troduced into Sicily on a much larger scale. Large
antities of citrate of lime are annually shipped to
reat Britain, the United States, Germany, and other
untries. Exact figures of quantity and value are
t available, but since this article has entirely taken
e place of shipments of concentrated lemon juice—
articularly at Palermo—it may be taken that the
ount is large.

GOVERNMENT AID TO GERMAN TRADE.

The German Government has in contemplation, says Consul Merritt, of Barmen, a measure which promises to be so advantageous in its operation that it seems worthy of attention. Every commercial nation in the world, with the exception of the United States, has a branch of executive government, the express functions of which relate to the control and development of commerce. Prussia has for many years been one of the foremost countries in the race and struggle for commercial development, and her *Handelsministerium* (Department of Commerce) has been of incalculable advantage to the entire German nation. It has been found, however, that because the Prussian Department of Commerce belongs to the kingdom of Prussia, the Minister of Cmmerce does not come into relation with the great departments of the Imperial Government in a manner which gives him proper standing, and the well earned consideration which would be his if he were an Imperial cabinet chief. Therefore, it is intended to consolidate the Handelsministerium of the four kingdoms into one Department of Commerce for the whole German empire. The German system, as it has operated in the past, has fostered the establishment of chambers of commerce, and trade organisations of a like character, in every community where there is room, and sufficient interest to warrant the establishment of such bodies. These bodies represent the quintessence of the great commercial life and element of Germany. There is no question connected with the development of trade interests, of manufactures, credit capacity of foreign countries, advantages to be obtained by treaty stipulations, injuries resulting from measures adopted by other nations in restraint of trade, which is not thoroughly discussed and carefully considered by the many German chambers of commerce scattered over the country. These bodies report to the Minister of Commerce with regard to the influence and bearing of all such matters, as they are connected with the commercial interests of the various localities, and, by petition or otherwise, they often secure action through their minister and the Minister of Foreign Affairs, which is of great advantage to them. The Minister of Commerce and his subordinates are in a position to know, with the greatest accuracy, all matters and details connected with the development and progress of commerce. Every chamber of commerce makes an elaborate report each year. Whenever a foreign Government seeks a benefit or a permission which includes an advantage to the commercial interest of the foreign power, the Prussian Minister of Commerce has always been enabled to secure a corresponding advantage for the commercial interests which it is his duty to guard. And when it appears to the Minister of Commerce in Prussia that foreign commercial enterprise is a menace to a local interest, great or small, steps are immediately taken, says Consul Merritt, to hinder the development of such enterprise.

COLOURING MATTER OF NATURAL WATERS.

The following abstract of a paper by Ellen Richards and J. W. Ellms in the "Journal of the American Chemical Society," is taken from the *Analyst*:—

The estimation of the relative depth of colour in natural waters is often of considerable importance, especially in places where the water is of surface origin. In the colouring matter there are probably several complex substances—tannins, glucosides, &c., and in some cases iron. While it is possible that nitrogen is often an essential constituent, yet experiments show that a large diminution in the nitrogen does not necessarily produce a corresponding lessening of the colour. Humic acid is also probably one of the compounds.

One of the earliest attempts to fix a standard of comparison so as to limit the allowable amount of colour was by oxidation with potassium permanganate. In a general way a rise of colour is followed by a rise in the oxygen consumed, but the results are often misleading.

The Nesslerised ammonia standards of Professor Leeds ("Proc. Am. Chem. Soc.," ii., 8) have been largely adopted, but are open to the objection that the tints are not of absolute quantitative value, but vary according to the different methods of preparing the Nessler solution. The metallic standard of platinum and cobalt (Hazen, "Amer. Chem. Jour.," xiv., 300) is satisfactory where only low colours are dealt with, but the authors find that the higher portions of the scale in a wide range of colour cannot be matched in this way with any degree of accuracy. They consider that the most reliable method is the use of stock bottles of the natural waters commonly met with. But since these, however carefully prepared, fade in time, some system of standardisation is necessary, and formerly Professor Leeds' standard was taken as the basis. The natural waters were diluted with distilled water, so as to correspond with the Nesslerised ammonia standards at a number of selected points. They now strongly recommend the use of Lovibond's tintometer for this purpose, and give tables showing the differences in the tintometric readings of red and yellow for each tenth of colour in the natural water standard scale.

Obituary.

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George Shaw.—Mr. George Shaw, Common Councilman for the Ward of Farringdon Within, who died at Dover on the 14th inst., was a member of the Society of Arts of 24 years standing, having been elected in 1862, and one of the judges for the Chicago Exhibition appointed by the British Royal Commission. Mr. Shaw was born at Dalkeith in 1822, and came to London at the age of 18. In 1 he entered into business on his own account, and fo years he carried on business as a builder, decorator, plumber at 20, King Edward-street, City. He t an active part in the public work of the Corporati In 1883 he was chairman of the City Commiss of Sewers, and in 1885 chairman of the Libr Commissioners. He was twice chairman of the C Lands Committee, and occupied the chair of seve other committees, and at his instance the Corporat commissioned Dr. Reginald Sharpe to write the w entitled "London and the Kingdom." At the ti of his death he was serving on the Bridge-ho Estates Committee, the Commission of Sewers, City of London Schools Committee, and the Libr Committee. He was a prominent member and former Master of the Plumbers' Company, and v the originator of the scheme for the regist tion of plumbers. He presided at the Plumbe Congress at the International Health Exhibition 1884, and suggested and superintended the erecti of the Old London street at this Exhibition, whi was carried out by Mr. G. R. Birch, the archite He was also one of the representatives of the Corp ration of London on the Council and Executive Co mittee of the City an Guilds of London Institu Mr. Shaw was author of a book entitled "Reviv Guild Action, with a history of the movement f the registration of plumbers," published in 1878, second edition of which was published in 1889.

General Notes.

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Pruning Fruit Trees in Italy.—The di advantages arising from the failure of fruit trees produce in successive years a uniform quantity fruit are well known to all engaged in fruit cultur and information regarding any system of cultivatic that has for its object the equalisation of successiv crops, especially when it is said that such system h been successful, must be of interest to them. Accor ing to Consul Seymour of Palermo, with the view equalising the crops in the Sorrentine Peninsul it has been shown that good results have bee obtained from the following method of pruning Prune considerably after the scarce year, cuttin some fruit-bearing branches, and little after the fu year. This system, though the opposite of the old seems to be in theory the proper one, for it is due t the fact that during the loaded year the tree is deprived of nourishment that might be used by it next year i the formation of fruit, and by depriving the tree o the branches which only deprive it of fruit, there wil be less nourishment required by the fruit in th following year, and the tree will have more for th formation of fruit.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society.

Papers submitted for the prize must be sent to the Secretary on or before 1st of October, 1896. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges no essay deserving the full award is sent in.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors shall send in descriptions of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

AN EGYPTO-ASSYRIAN RAILWAY AS THE NEW OVERLAND ROUTE TO INDIA.

By Colonel A. T. Fraser, R.E.

A visit to the Persian Gulf and Mesopotamia during three months' leave last winter so impressed the writer of this paper with the advantages to be immediately obtained by establishing a new overland route to India across Arabia, that he drew up a short paper on his return to Bombay, dated 21st February, 1895, with a view of interesting the Royal Geographical Society in the matter. Before, however, it got placed before that body, Mr. Black's exhaustive article, "The Railway to India," appeared in the "Contemporary Review," very much extending the scope of the enterprise beyond that contemplated in the paper, or to, in fact, its ultimate proportions, of an Imperial trunk line of railway with the terminus at Singapore.

But the aim of the present (as of the first) paper is to show that most of the benefit, as far as India is concerned, will be gained the moment Egypt is connected by railway with the head of the Persian Gulf.

It is quite unnecessary to wait for the inevitable continuation of the line along the Persian and Mekran coast to Kurrachee. Almost every object will be attained by merely laying about 1,000 miles of railway across Arabia, in particularly easy desert country, which could be done in a year. It is also safe to say that no line of that length ever projected was charged with the same profound influence on Indian trade and welfare, likely even to exceed that due to the opening of the Suez Canal.

The Arabian overland route is, as Mr. Black's article maintains, an entirely new idea. Hitherto, ever since the noteworthy Chesney expedition, the Euphrates Valley Railway has been always talked of as the coming link between England and India. The intention was to found a British port at Alexandretta in North Syria, and take a railway across country to Birehjik, at the head of the Euphrates navigation, and down the banks of the river to end at the Persian Gulf. Upon any one who travels that way now, and takes our position in Egypt and protectorate over Asia Minor into account, objections rise thick to the Euphrates Valley Railway as being the best route to India. To begin with, Alexandretta is not well situated as a terminal Mediterranean port; it is a place infested with malaria, and exposed to the full tide of international complications. Then the Sublime Porte has long ago conceded a railway right athwart Asia Minor, from the Bosphorus into the heart of Assyria, and this is already open as far as Angora, the exact course to be taken after reaching Mosul being as yet undecided.

It is manifest by a mere glance at the map that the line thus conceded when duly prolonged to Kurrachee is the straightest that can be made between the English Channel and India. With a second Forth Bridge thrown across the Bosphorus at one or other of the favourite sites for such at Constantinople it would be in the future the only continuous through route by railway. But owing to the insistence by the Porte that railroad concessions can only be given to Turkish subjects, great delay is occurring in Syrian lines, while the time-honoured necessity of *bakshish*—or greasing of official palms—comes in awkwardly at every step on Turkish soil by which real progress is effected. A Calais-Kurrachee through train is after all, a superfluity to a power like Great Britain with a maritime trade and sea command.

There are in the meantime urgent problems demanding solution connected with our temporary occupation of Egypt on the one hand, and the Indian Empire with its nascent home rule aspirations on the other. These would be at least greatly simplified if the distance between India and the Mediterranean were reduced to a quick and cheap five days' journey.

The existing so-called "overland" route ceased to be such at all, properly speaking, on the inauguration of the Suez Canal. It is in reality a very circuitous Red Sea route, liable to be blocked, and to have British traffic diverted round the Cape again at scant notice.

Laying a railway between Ismailia and the head of the Persian Gulf would at once alter the whole complexion of affairs, at a cost of some £5,000,000 sterling, because the steamers already trading to India can do all the remainder of the work. The new overland route could be opened for mails, passengers, and the relief of European troops at the running through of the first Arabian train from Egypt.

Nor are there any special engineering difficulties to encounter. From Ismailia, after crossing the Suez Canal by either a subway or a swing-bridge, there would be a plunge into the winding valleys and sublime desolation of the desert of Sinai; and then the line would make for the head of the Gulf of Akaba, for convenience of access and protection by the British flotilla in the Indian seas. The only at all heavy engineering operations would be in crossing the deep valley above Akaba, which is a continuation of that of the Jordan, and getting upon the tableland of Arabia. Once on that elevation, there is nothing to be expected but the stony desert ring, which Palgrave speaks of, and monotonous undulations of a gravelled surface, with the hollow pass of the Jowf midway, all the rest of the distance down to Bussorah.

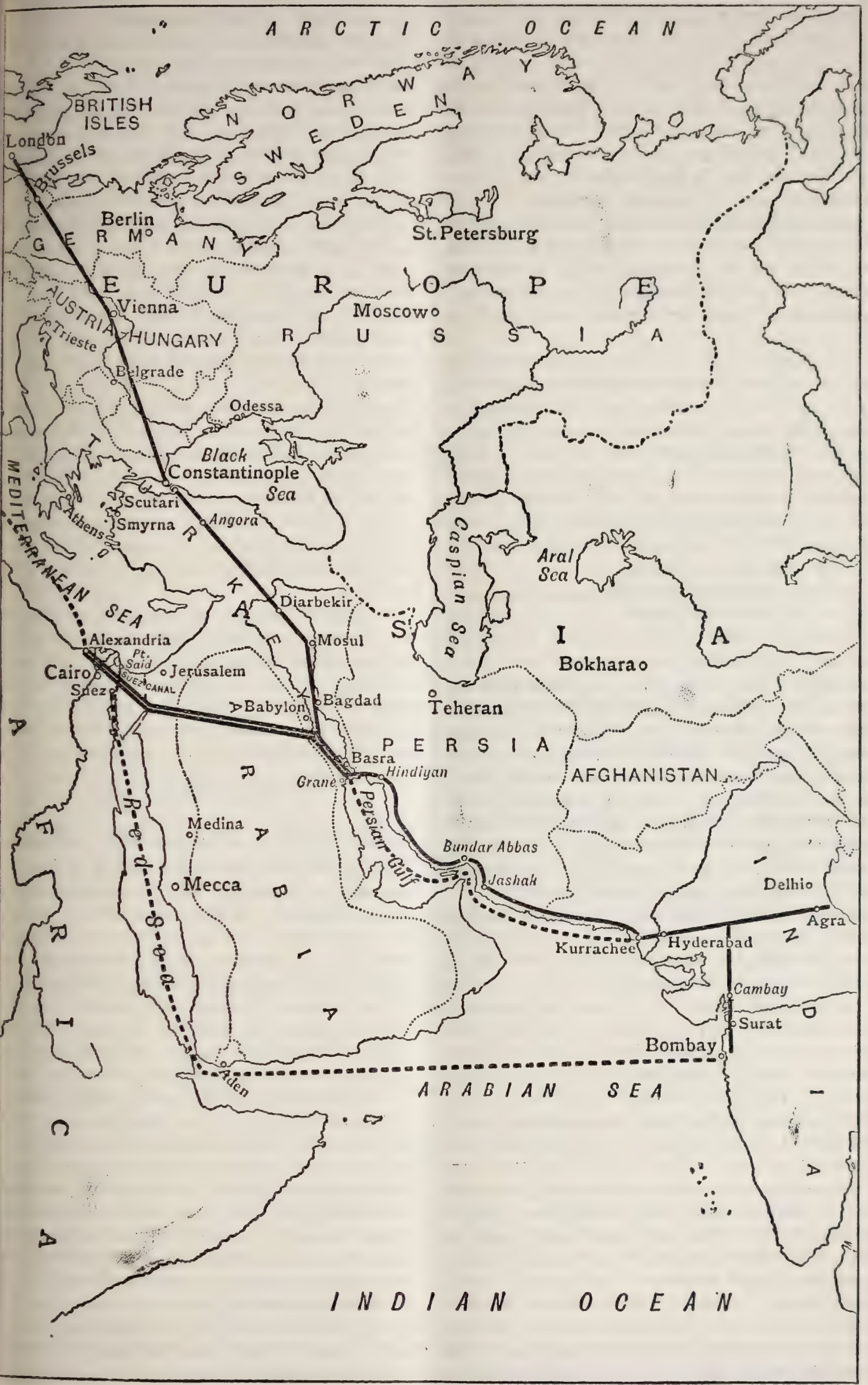
The route across Arabia is consequently the most favourable possible for a railway; crosses an insignificant amount of drainage, and is remarkably clear of settled inhabitants. There is not a Turk to be seen. It is true a few Arab tribes have the limits their wanderings as accurately defined withou enclosing marks as an Australian squatter' "country" is with his wire fence. But the railwa need not encroach on any Arab rights; it will, o the contrary, be warmly welcomed by them, as givin access to markets, and its safety can be ensured wit complete certainty by fixed payments to the trib sheikhs, and a permanent understanding with th Arab ruler of Nejd, the most picturesque state i Central Arabia. Indeed, a hundred miles breadth desert would probably lie between any of the Nej centres and the railway.

The point to be aimed for in Mesopotamia, as th junction with the Assyrian line from Constantinopl is of importance, and will, for topographical reasons be somewhere near Bussorah, where the combine Euphrates and Tigris—known as the Shatt el Ara (or Arab river)—is narrow, and where a bridge mus be placed when the line is carried round along th coast of Persia and Beluchistan to Kurrachee. Thi junction will be so important because it is through i that the supply of coal for the new route, its railways and its steamers will most likely be derived. Th writer made an excursion to Hit, on the Euphrates about 90 miles above the site of Babylon, wher bitumen springs were flowing in the time of Hero dotus, and still furnish asphalt for export. Th geological appearances suggest the existence of vas beds of coal at no great depth, accompanied b stores of petroleum.

But returning to the main subject, in order to star the new overland route without any delay, it i necessary to carry the line 80 miles south of Bussora to the deep water anchorage of the port of Koweit and clear of the muddy bar at the mouth of the Shat el Arab, which is at present impracticable for larg steamers. The new route will then have Alexandri at one end and Koweit at the other extremity.

As fast vessels can make the run down the Persian Gulf from Koweit to Kurrachee in less than thre days, and it will not take more than a day to cros Arabia by rail, there is an enormous lessening of the time—and, therefore, cost of transit—between the Mediterranean and India. It will only take four days where it now takes ten. The reduction is all the more striking reckoned from Bussorah, whose mails will reach Egypt in one day, that now require 19 days to get there,

The effect, politically, of the simple and comparatively inexpensive measure of connecting Ismailia and Koweit by railway is nothing short of transferring the commercial frontier of the Indian Empire at one sweep from Sind to Alexandria, for it is apparent that only at Alexandria can the harbour facilities, combined with adequate protection, be got for the vast Indian trade the railway would bring. What arrests the frontier on the borders of Sind is, seemingly, the strip 1,000 miles long of stony deserts, to be had almost for the asking, and very nearly ready for the platelayer to commence his operations.



Walker & Boutall sc.

ROUTE OF PROPOSED EGYPTO-ASSYRIAN RAILWAY.

To the individual camel rider with a small caravan, it is, of course, a very formidable tract of country to go through, and personal experiences are always novel enough to fill a book. Very few have made the journey. But a party of well-equipped engineers operating from a base, and sinking for water as they proceeded, would very soon find difficulties vanish, and that they had in hand a prosaic task. There would not even be political excitement, for the Turkish officials and Arab sheikhs, who have received a fee are the most agreeable company possible, and so out of the way is the region that it is positively beyond the spheres of influence of any of the competing powers of Europe, by no means the case in Syria and Asia Minor.

For private interests and commerce there would be the great advantage of a daily mail (six times a week) to India. As it is there is almost daily steam communication between Continental ports and Alexandria. The Persian Gulf is not long and is easily navigated, while there are any number of steamers available on that side trading to Bombay, so that daily mails from London to Kurrachee, taking a week in transit, could be begun simultaneously with the opening of the Arabian railway.

The new route would finally be the equivalent of a large addition to the defence force of India and render Egypt independent of a special garrison of occupation. Into this part of the question it is not necessary to enter deeply. But at present there are some 12,000 troops passing annually in relief between England and India during the cold season. From the time they leave the docks till they arrive at Bombay these troops are out of sight and their services are of no use to the Empire. It would be very different if the reliefs were all landed at Alexandria, taken through Egyptian territory and across Arabia in a stream of vigorous detachments, with only three or four days more of sea passage to reach Kurrachee. The Persian Gulf has the reputation of being in summer the hottest sea in the world. So it must be felt by those who can only crawl along its waters in cargo vessels, half the time swinging at anchor at the dreariest of ports. But in a well-appointed steamship the inconvenience of extreme heat, lasting barely for three days would be scarcely noticed. As a depôt for European troops Kurrachee is much superior to Bombay. It is just out of the tropics, has only an average of seven inches of rain yearly, and the climate is not nearly so deteriorating to the European constitution.

To recapitulate, the immediate results from a railway a thousand miles long, costing five millions sterling, from Ismailia to Koweit, would be as is claimed by this paper—first, the virtual extension of the Indian frontier westward by 20 degrees of longitude; second, a daily mail to India, and cheaper passages; thirdly, an economical trooping service; fourth, the salubrious port of Kurrachee, taking the place of Bombay as a depôt for mails and passengers; fifth, Alexandria becoming practically the port for Western India; sixth, the opening of a coalfield i Mesopotamia; and, lastly, termination of all uncertainty with respect to our Egyptian policy.

Of course, the construction of these railways t Mesopotamia, would be speedily followed by an ex tension of the British line from Bussorah along th northern shores of the Persian Gulf and the Mekra coast, to meet the Indian system of railways converging in Kurrachee. There is no difficulty in takin a railway over the low strips of land at the base o the chain of mountains which bound the plateau o Persia, and overlook the sea—the late ill-starre American traveller, Lenz, did the trip on hi bicycle — and the whole length of line would b under the observation of our fleet in Indian waters giving Great Britain a material stake in the Persia littoral.

Branch lines of railway, as indicated by the lat Sir Oliver St. John, and recommended by Sir Frederi Goldsmid to the British Association at Leeds in 1890, would bring down the trade of Souther Persia to its old centre at the Straits of Ormuz, connecting the Port of Bunder-Abbas with Bagda *viâ* Shiraz and Ispahan, and giving Indian passengers a cool alternative route for a section of thei journey.

But the directness and advantages of the Egypto-Assyrian route over that advocated by the Euphrates Valley Railway are so marked that the new overland route has to be considered apart from the extensive system of Persian lines to which it must inevitably lead, and those railways in Turkish territory with which India has no present concern.

TRADE WITHIN THE BRITISH EMPIRE.

The Secretary of State for the Colonies, on the 21st November last, mailed to the Governors of all the Colonies a despatch, in which he said:—"I am impressed with the extreme importance of securing as large a share as possible of the mutual trade of the United Kingdom and the Colonies for British producers and manufacturers, whether located in the Colonies or in the United Kingdom. In the first place, therefore, I wish to investigate thoroughly the extent to which in each of the colonies foreign imports of any kind have displaced, or are displacing, similar British goods, and the causes of such displacement." He therefore asked for a return, showing for the years 1884, 1889, and 1894 the value of articles specified in the classification annexed to the despatch, and the reasons which may have in each case induced the colonial importer to prefer a foreign article to similar goods of British manufacture. These reasons (to take the shape of a report on each article separately) were to be classified and discussed, and were to refer to price, quality, and finish, suitability of the goods for the market, style or pattern, difference of making up or packing, &c.

In reply to Mr. Chamberlain's despatch, specimens goods of foreign origin which have displaced, or e displacing similar British goods have been re- ived from Trinidad, Bermuda, Bahamas, Barbadoes, d St. Lucia, and these embrace articles classed under e headings of apparel and slops, cordage and twine, otton manufactures, hardware and cutlery, hats, nplements and tools of industry, leather manufac- ires, silk manufactures, woollen and worsted manu- ctures, and refined sugar.

These goods are now exhibited at the offices of the ondon Chamber of Commerce, Botolph - house, astcheap, and will probably remain there until the 2th inst. The exhibition is open daily from 11 a.m. 4 p.m. (and to 1 p.m. on Saturdays), and admis- on to view may be obtained on presentation of usiness card. The fullest information respecting e articles sent in reply to Mr. Chamberlain's des- atch has been received from Trinidad. One of the xhibits to which special attention is drawn consists f samples of packing, showing the inconvenient rown paper parcels in which hardware is sent from reat Britain, and the more convenient cardboard oxes used in Germany, America, &c.

The samples include, under the head of "apparel nd slops," two pairs of moleskin trousers from ermany, priced 1s. 8d. a pair, which are accom- anied by the statement that the estimated importa- on from Germany and France is equal to 75 per ent. of the whole. British-made clothing is alleged be too heavy for the climate, and too expensive, esides which it is not considered "showy" enough r the native market. In the articles of cordage and wine, the patterns include one bundle of Catalan wine from Spain, and one pair of rope slippers from rance. In regard to this branch of trade, it is said at it has been, and practically remains, British, xcept as concerns "sisal," which is usually American r German, owing, as is alleged, to the cheapness f the productions of those nationalities. The twine much liked, and the slippers, which are landed t 4½d. per pair, are also popular. In articles of otton manufacture the patterns forwarded are two ounterpanes, and two specimens of fancy coloured rills from Germany; also three specimens of "duck" om Germany, and four books of patterns of piece oods from Germany. It is stated that the trade in 'piece goods" is nearly wholly British. The drills rom Germany are preferred for the patterns and the rice charged for quality. Of stockings and socks, 34 atterns of German products are forwarded, and the easons for their preference are that for the prices he articles are very good and of attractive appear- nce. Of hosiery the patterns include two pairs of races and one blanket from the United States, wo undershirts from Spain, and one undershirt from rance. It is stated that the Spanish undershirts epresent a class of goods largely sold in Trinidad, ecause well suited to the climate and cheap, and ecause also they are unattainable in Great Britain. f shirts there are four samples from Austria, in espect of which goods an immense trade is done. They are, with one exception, of inferior quality, but are got up in a style which suits the market.

As to china and earthenware, of which there are no exhibits, it is stated that the superiority o British ware is generally admitted; but it is described as "too good for the market." The consequence is that probably two-thirds of the trade is foreign, owing to the greater cheapness and lightness of the foreign ware, the conveniently-sized packages, which facilitate transhipment to South America, and the greater care with which the goods are packed. As to furniture, it is stated that insects and the moisture of the climate quickly injure goods coming under this head, and the goods in general use in Great Britain are too expensive and massive. Bentwood comes in large quantities from Austria, and much light furniture from America. The best furniture, however, comes from Great Britain. In hardware, samples are forwarded of goods from the United States, Germany, and Great Britain. The locks and latches, both German and American, are said to be very cheap, and some of them notable for ingenuity. They are preferred to British locks because they can be easily fitted by unskilled labour. The tinned iron spoons from Germany are also said to be remarkably cheap. In cutlery, of which samples of scissors made in Germany are forwarded, it is stated that, except in regard to cheap goods of this class, Great Britain has a monopoly of the market; but, in the case of the heavier goods, America has an advantage in lower freights. Kitchen articles mainly come from Great Britain, except the enamelled goods, which are sent from Germany. In hats of woollen, straw, and other materials, Great Britain has the most remunerative portion of the trade; but the wool hats from Italy are in large demand. In implements and tools of industry, the bulk of the trade is British, with certain exceptions, America sending the cheaper shovels and hatchets, though they, in turn, are being beaten by Swedish goods. The cheap tool handles cannot be rivalled by Great Britain. In boots and shoes the trade is chiefly foreign, being divided among Austria, Switzerland, Germany, France, and the United States. It is pointed out that the West Indian boot is of a different model from the English.

Medicinal drugs are said to come chiefly from Great Britain, though there is a large and increasing importation of proprietary medicines from America. Metals come mostly from Great Britain, while the ironwork for building purposes, though purchased in the United Kingdom, is of Belgian origin. Musical instruments, virtually confined to pianos, are mostly imported from Germany. In plate and plated wares the trade is almost equally divided between Great Britain and the United States; while in silk goods the bulk is imported through Great Britain, though much of it is of German or French origin. Stones and slates are chiefly imported from America; umbrellas and parasols are almost equally divided between Great

Britain and foreign countries; wood manufactures are received solely from Canada and the United States; mixed wools are generally of British manufacture, though Germany has a large share of the "whole wool" trade, owing to her prices being lower, and the patterns more attractive. The trade in hearth-rugs and carpets is mainly British, but the American goods are beginning to find a market on account of their cheapness.

The Chairman of the Barbadoes Commercial Hall (Mr. J. Gardiner Austen, junior) states that, with some few exceptions, nearly all the manufactured articles imported come from the United Kingdom—viz., apparel of all kinds, boots and shoes, millinery, haberdashery, cotton, linen, silk, wool, glass, earthenware, china, hardware, machinery, manure, metals, minerals, salt, beer, and soap.

The articles which are displacing British goods are canvas, cordage, nails, tools, carriages, and furniture. The reason given for the use of American canvas is because the sailing trade is principally of United States or British American origin, as the English carrying trade is all done by steamers. Manilla rope, manufactured in the United States, is more flexible and of better finish than English and is preferred although it is dearer. Other kinds of cordage are mostly of English manufacture. Nails sent out from the United Kingdom are largely of foreign manufacture. Carriages and furniture of foreign manufacture are lighter and more suitable to the climate although they are no cheaper than the English.

Direct importations from British America are confined mainly to cured fish, white pine, spruce lumber, shingles, hay, and oats. Canadian flour is said not to keep long in tropical climates. Foodstuffs are largely imported from the United States. In water carriage and freight the United States have a great advantage over the United Kingdom. Though most of the foodstuffs come from America, the better sorts—such as candles, ham, bacon, cheese, groceries, jam, and biscuits—are imported from Great Britain.

The exhibits from St. Lucia consist of samples of hosiery, silks, boots and shoes, and hardware. Those from the Bahamas are composed of cotton manufactures, hosiery, boots and shoes, and hardware. and from Bermuda of cotton goods solely.

The samples from St. Lucia, the Bahamas, and Bermuda are accompanied by descriptions and prices, but without any accompanying statement as to the reasons why certain articles from foreign countries have a preference over those manufactured in Great Britain, such as is given in the reports received from Trinidad and Barbadoes.

The chief points which seem to arise for consideration in respect to the samples that are now exhibited are—(1) suitability of the goods to the tastes of the people supplied; (2) mode in which the goods are presented to the purchasers, packing, &c.; and (3) cheapness. With regard to the last point, some of
the exhibits are bad, as, for instance, the cheap sa
and there could be no advantage, but rather
reverse, in Great Britain attempting to supply go
similarly "cheap and nasty." Other points
probably arise, when further supplies from ot
colonies arrive.

Samples of imports have been received from M
bourne and the island of Cyprus, and these will
exhibited later on. When the majority of replies
the despatch have been received the exhibits will
circulated throughout the country.

THE MINES OF ANGORA.

In a report entitled "Le Vilayet d'Angora:
Industries et ses Resources," M. D. Arslanian, Co
troller of Mines and Forests in Angora, says th
from the earliest periods Anatolia has been engag
in working valuable mines. Silver, copper, and ir
are found in abundance, while zinc, sulphur, a
other non-precious metals are found in some qua
tities. To judge from the numerous applications th
are made to the authorities for mining permits, t
general impression would appear to be that gold a
silver are also to be found. M. Arslanian says tha
because the mining industry is not in a high sta
of development in Asia Minor, it would not
correct to assume that this industry does not off
considerable opportunities of success and profit.
a matter of fact, the majority of those to who
concessions are granted in Turkey are content
entrust their interests to persons who have litt
technical knowledge, and thus their profits are smal
All those mines which are worked in a proper an
rational manner are lucrative undertakings. Certai
metals much used in modern industry, such
chrome, aluminium, manganese, &c., abound
Asia Minor, and many of these metals are bein
mined in Angora, while the opening up of coalfield
is expected, in the near future, to completely chang
the face of the country. In the sandjak of Angor
which has an area of about 36,000 kilometres, ther
are not less than 37 permits applied for, for th
working of coal, and great things are expected fron
this industry, which is being encouraged not only fo
its own sake, but also because it will conduce to th
conservation of the forests, which, unless radica
measures are taken, will soon be destroyed. Th
principal mines of Angora are those of argentiferou
lead in Akdagh-Maden, towards the east of th
sandjak of Yozgad, and in Denek-Maden in th
sandjak of Kirchehr, but up to the present these hav
been of no practical value. It is only the clay o
Mihalidjik, to the east of Angora, occupying a
immense area, which for many years has been suc-
cessfully worked, and is still capable of further exten-
sion. This Mihalidjik clay, known as *kil* in Turkish,
is a greenish grey earth. It forms an immense bed,
having its chief centre in the environs of the little
town of Mihalidjik, in the *caza* of the same name,

d it extends towards the west as far as Kutahia, d towards the east to Yozgad. At the central int of the workings there are whole mountains mposed entirely of this clay. In the *caza* of Beyazar there are also found mountains of this *kil*, hich, however, is of inferior quality. Clay is also und in the *cazas* of Ayache, Zir, Bala, Tchibouabad, Kalédjsk, as well as at many places in ozgad and Soungourlou, and in the environs of ivas, and in the sandjak of Balikessir, to the west f the vilayet of Broussa. This clay possesses in a igh degree the quality of dissolving fatty substances. t is sold in its natural state, and is employed, just as is, in washing, with the addition of a little soap, r even without soap. It is stated that the clay is etter for washing linen than an equal amount of oap. The working of *kil* was sold by the Governent for five years ending February, 1894, for 5,000 Turkish pounds per annum, and the consumpon is estimated at from 8,000,000 to 9,000,000 kilorammes annually. At Mihalidjik there is also und a spring of argillaceous water, which is much sed for removing stains from clothes. M. Arslanian ays the establishment of a factory in Angora for the anufacture of soap composed of *kil* would proably turn out a profitable business. Although the ilayet of Angora appears to be rich in mines of all inds, very little up to the present has been done to evelop them, but by a recent Iradé, an inspector f mines has been appointed for the vilayet, and t is anticipated that this measure will give n impetus to the metallurgical industry. The alines of Angora are divided into two classes, rock-alt mines, and artificial salines. Both are comrised among the revenues conceded to the Adminiration of the Ottoman Public Debt, of which salt onstitutes, after tobacco, the principal resource. The ilayet of Angora possesses very important salines of hich the principal, those which are actually worked, re concentrated in the three *cazas* of Kirchehr, édjidie, and Soungourlou. According to a work y M. Cuinet on Asiatic Turkey, the annual revenue f the Hadji-Bektache salt works is estimated at a illion of paras. The beds of rock salt of which this ine is formed are at a depth of about 30 metres. he inhabitants of Touz-Keny, a village situated at short distance from the mine, are the only ones mployed in the extraction of the salt. Like nearly ll the provinces of Anatolia the vilayet of Angora ossesses a large number of mineral springs, it is owever at Broussa only that establishments are und responding to the exigencies of modern taste, hile the baths of Angora are in a more or less rimitive condition, although from a therapeutic point f view these are as valuable as those of Broussa. The ost renowned springs are the following :—The *izildja*—there are two springs bearing this name, uite close to one another. Kizildja is about four ours journey from Tchorba, chief place in the *caza* of abanabad. The waters of Kizildja are sulphurous. he *Sey* springs are situated in Sey-Hamam, abou 35 kilometres north-west of Tchorba, in the midst of pine forests. The waters are carbonated. The *Itchmédjé* baths are in the town of Ayache, 50 kilometres west of Angora. These springs contain sulphate of magnesia, and are much frequented by invalids. The *Yapan* springs are situated in Yapan-Hamam, which is the chief place of the *caza* of Haymana. This is about 60 kilometres south-west of Angora and 30 kilometres from the Polatli station. These are sulphurous springs. The *Ilidja* springs are in the village of the same name, about 30 kilometres from Yapan. This bath was constructed in the Byzantine period, and was then much frequented. The *Hamam-Kara-Hissar* springs are in the village of the same name, about 20 kilometres from Sivrihissar, and these are ferruginous and sulphurous. The *Yildizli* springs are situated about 50 kilometres south-west of Angora. Among other mineral springs are the following :—*Gumendy*, near Stanos; *Paoli-Hamam*, at Beypazar; *Zervéli*, near Kirchehr; *Yarikdji-Hamam*, at Mihalidjik; *Hassan-obé*; *Thermé* and *Kara-Koran*, in the town of Kirchehr; *Gueuz* and *Sazlik*; *Sorkown*, near Yozgad, and a large number of others.

THE PRODUCTION OF CLOISONNÉ WARE IN JAPAN.

The production of cloisonné goods was, says the Swiss Consul at Yokohama, introduced into Japan from China in the 16th century, and was started at Nagoya, which is still the head-quarters of the industry, although it is successfully carried on at other places. Owing to the great spread of Japanese curios, favoured by the fashion of the day, almost everyone is acquainted with the Chinese or Japanese cloisonnés, those vases, plates, or other metal objects coated with a shining enamel of many colours, and ornamented with strange drawings and designs brought specially into relief by the coloured enamels. An authority on Japanese art gives the following interesting account of their manufacture. The copper vessels are provided internally and externally with projecting rims of brass, the height of which determines the thickness of the layer of enamel with which the objects are to be coated. The outlines of the design are marked on the copper with white lead. Following the lines of this design, narrow strips of brass are bent by means of wire pliers into all sorts of small shapes over a glass plate. The strips so bent are fastened by their edges to their places on the design, at first temporarily, by means of a special cement, and later on, more durably by an easily melted solder. After this process, the surface of the vessel appears entirely covered with a network of cells. These cells are then filled out with powdered vitreous matter reduced to a paste by the addition of water; when these coloured enamels are dry, the vessel is placed on the furnace for the first time. During the burning process the colours harden and sink beneath the level of the edges of the cells. All these depressions are filled up after the vessel has cooled, and it is then heated again, the process being repeated until all the cells are equally full. Finally, the surface is smoothed and polished, and receives a questionable improvement by means of vegetable wax and a coat of paint. The enamels are burnt in small vessels which are not placed in special furnaces, but have charcoal packed round them, which is fastened by wire and set alight. This apparently primitive process allows the intense heat to be suddenly withdrawn by snatching away the charcoal; this prevents the enamel, which readily liquefies, from running out of the cells, and consequently seems necessary to the success of the operation. A similar process has also been adopted within the last few decades, principally at Nagoya, for ornamenting porcelain and earthenware vessels with enamel in cells. For this purpose the surface which is to receive the enamel is left unglazed, and the solder falls away, whilst the enamel adheres tightly to the rough earthenware surface as a kind of glazing. At the Tokio Exhibition the cloisonné makers of Nagoya were represented by numerous exhibits, some of which were very fine, but it is stated that really good specimens of this ware are very dear. Very small vessels, with the cell walls made of silver, were marked at 150 yen, rather larger ones, with splendid colouring, at 175 yen. Instead of using copper vessels, manufacturers have already begun to produce vases of solid silver; this, of course, considerably increases their cost.

THE PRODUCTION OF PULQUE IN MEXICO.

The United States Consul-General at the city of Mexico says, in his last report, that it is impossible to separate in thought the average Mexican and pulque. No drink has a stronger hold on any nation than this on the Mexicans, and by Mexican is meant all classes in Mexico, other than the Spaniards. Pulque is not the drink of the Spaniard or those of Spanish descent; they drink champagne, claret, sherry, and other imported wines. Among the peons, men, women, and children drink pulque with the same freedom that water is used in Europe. The pulque plant is indigenous to Mexico, often growing wild on the uplands, where—for months and years at times—no rain falls; and it is also largely cultivated in the most careful manner on the *llanos de Apam*, a large area of plains lying about 60 miles from the city of Mexico. In Spain a plant is found, called *pita*, somewhat akin to the pulque plant, or Mexican maguey, yet differing so much in its general features, that it may be termed a distinct genus. The juices of the pita are unused in Spain, which fact plainly separates it from the family of plants in Mexico. The plants are transplanted when two or three years of age with much care, then cultivated in fields especially prepared for this purpose. Nature requires the plant to be "milked," wh
the liquid is ready to flow, else the superfluity
juices will cause the growth of a large stem fr
the centre of the plant, shooting up some 15 or
feet, putting out branches at the top, which bloss
in a cluster of yellowish flowers. These branches
symmetrical, and the effect is like a lofty bran
candlestick. When the pulque is first extract
—before the process of fermentation sets in—it
sweet and scentless, and in this state is preferred
beginners. The fermentation takes place in tu
made for the purpose, and to aid or expedite the p
cess, a little *madre pulque* is added, which haste
the chemical change. At times its fermentation
retarded by a cold spell at the vats, which preve
its transport to the city for a day or two. The c
of Mexico has a population, it is said, of 350,000, a
at least 250,000 of these use pulque, in preference
water or any other drink. It has been stated th
75,000 gallons of pulque are consumed daily in th
city. The stock must be renewed daily, or else
becomes dead and insipid, though, it is said, a certa
powder has been discovered which will prolong its l
through the second day. The liquid ferments rapid
and strongly, and the casks are left uncorked to pr
vent explosion. The plant grows eight years befo
maturity and the liquid is extracted. In the grow
of the plant, a central bulb is formed for its comi
juices. This is scooped out, leaving a cavity lar
enough to hold a few quarts. This cavity
made in the bottom and middle of the plan
The juice exudes into this cavity, and it is tak
out daily by being sucked into a long-neck
gourd, on the syphon principle, by the India
labourers, and then poured into the tubs and th
removed to the vats. The outlay on each plant up
maturity is calculated generally at about 8s., and th
return is from 30s. to £2 according to the size of th
plant. Its producing life is about five months, an
each plant is supposed to yield from 125 to 1
gallons of liquid within that time. The immen
fields within a radius of 75 miles of the city of Mexi
are planted and cultivated with great care and pr
cision as there is nothing grown in Mexico that pa
better than pulque. Fields of it present an attracti
appearance, planted in almost geometrical regularit
extending almost beyond the vision, until the ro
seem to concentrate in one plant and into one poi
at the extreme end. The plants are wholly ind
pendent of rain and storm and are of a beautiful dee
green colour. It is said that as much as 1,0
dollars a day are paid for carriage on the speci
trains for transporting this liquid into the city
Mexico. The tax on pulque is collected at *garrit*
or gates, before its admission to the city, and the
the liquid is distributed in the barricas and pigski
on special carts held in readiness for that purpos
Consul Crittenden says that nothing presents a mo
ridiculous appearance than one of these pig
hog skins containing about 20 gallons, when bein
taken round and through the city, the legs stick

g out full to the toes, of liquid. This is a connient mode of handling the pulque, as by simply moving a string from one of the feet the connts are drawn out. The culture of the maguey the Republic of Mexico is unquestionably ineasing very largely; but it would be a mistake draw the conclusion that arable land is therefore ithdrawn from the cultivation of cereals and vegebles. Careful observation will convince everyone at the haciendado only plants the maguey in large eas, where nothing else will grow; and nothing is ore common than fringes of maguey, like hedges, ound fields of wheat and corn; but where the whole panse of land is covered with maguey, it is because e soil is too poor to produce anything else. The incipal regions for the cultivation of the maguey re the arid limestone chain of hills; and here, in any places, the hole for the insertion of the young lant is made with a sort of crowbar with a sharp oint, used principally in the extraction of *tepatate*, he chief building material of the Mexican capital. t is usual to aid the young plant by inserting some ood soil into the hole. These young plants are uckers, which the mature magney throws out on all ides, and which have to be removed before the eart is tapped for the sweet sap, which is the *agua niel*, or honey water of the pulque. When the abourers draw the sweet sap with their rude syphon, nade either of a gourd or a calabash and a hollow orn tip, they discharge the contents into a pig or oat skin swinging at their backs. The *agua miel* t this stage is like green water in appearance. Some arbonic acid is formed, and it becomes milky, and esembles in taste very good cider. The amount of arbonic acid contained is so great, and the decomosition so remarkably rapid, that in a few hours it would become vinegar, if not closely watched. To revent this, the *pulque dulce*, or sweet pulque, is poured into a *tinnacal*—an ox-hide strapped to a square wooden frame, and capable of holding a considerable amount of the liquid. These tinnacals are of various sizes to meet the emergencies of the situation. To the sweet pulque is added an equal proportion of milk, and then a slight dose of infusion of rennet. This is not enough to coagulate it, but sufficient to induce a slight amount of putresence, as in cheese. The putrid odour and flavour of pulque, as sold in the *pulquerias*, is due to the rennet alone; for the belief that this is caused by the flavour of the pigskin, in which it is brought to market, is entirely without foundation. From the tinnacal it is poured into hogsheads, by means of pigskins, and it is transferred to the barrels of the vendors from the hogsheads of the haciendado by means of the same skins. In both instances the pulque remains in the skin barely more than a few seconds or minutes before the transfer. The rennet added in the tinnacal is the real cause of the putrid flavour and taste of pulque, and this is removed in private families by means of a chemical substance of a perfectly innocuous character, and some housekeepers add white sugar, and others the juice of oranges. It is a regrettable fact that, in the pulque shops, the beverage is made intoxicating to a maddening degree by the addition of *marihuana*. The Government has made, and is making, every effort to stop the sale of this noxious compound. Consul Crittenden says that the number of deaths from fights in pulquerias in Mexico is incredible. Those whom the poison does not madden it stupifies, and in every great festival, particularly when there are public displays of fireworks, the police have hundreds of persons to look after, who are absolutely helpless from drinking drugged pulque. The leaves of the pulque plant are long and pointed, with prickles along the edge. Sometimes these leaves are very large, and the bunches of them, springing from the common stock, are enormous. The bruised leaves are made into a common paper—rather a tough, stiff, and hard paper—and they are also used in their natural state as a protecting thatch for the roofs of the common huts or houses occupied by the peons. A kind of thread is also made from the fibrous texture of the leaves, and a rough needle and pin are made from the thorn, and from the root a cheap and palatable food is made. It is not, therefore, a matter of surprise that the peon class think very highly of the pulque plant in Mexico.

Notes on Books.

SHAKESPEARE'S TOWN AND TIMES. By H. Snowden Ward and Catharine Weed Ward. London: Dawbarn and Ward.

Mr. and Mrs. Snowden Ward have added a useful and prettily got up book to the already large mass of Shakespeare literature. They state their object to be—"to write in plain words the tale of Shakespeare's life [and], to picture what remains to us of the scenes that Shakespeare saw," and they have carried out this object well. They have fully illustrated the district which is for ever associated with the great poet's name, and brought their book up to date by an account of all that has been done of late years, by the erection of theatre, library, statue, and fountain, &c., to make the little Warwickshire town a true memorial of its greatest native. The titles of the various chapters into which the work is divided are as follows:—(1) The town and district; (2) some historical notes; (3) Shakespeare's ancestors; (4) Shakespeare's childhood; (5) Shakespeare's boyhood; (6) Shakespeare's youth and courtship; (7) seeking a fortune; (8) manhood and the close of life; (9) a great man's memory. Besides the numerous views and other illustrations there are a map of the district and a plan of Stratford-on-Avon. The frontispiece shows the Davenant bust which was found during some building operations at the Royal College of Surgeons at Lincoln's-inn-fields, and was bequeathed to the memorial library by Sir

Richard Owen. The authors also describe and reproduce the curious and interesting oil painting which is very generally supposed to be the original of the Droeshout engraving, prefixed to the folio editions of the plays. Another interesting portrait, to which allusion is made, is that known as the Stratford portrait, which was presented to the Birthplace Trust by Mr. William Oakes Hunt.

Power Locomotion on the Highway: a Guide to the Literature relating to Traction Engines and Steam Road Rollers, and to the Propulsion of Common Road Carriages and Velocipedes by Steam and other Mechanical Power, with a brief Historical Sketch. By Rhys Jenkins. London: William Cate.

The literature of any subject that specially attracts public attention grows at so great a rate in these days of rapid publication in periodicals, that a bibliography becomes a necessity for students. Mr. Jenkins has come forward with such an aid to the student of the literature of Power Locomotion on the Highway. This bibliography consists of a list of separate publications, a catalogue of papers read before scientific and technical societies, and an index to periodical literature to the end of 1895. The number of journals specially devoted to the mechanical carriage movement is given as six, and these papers are published respectively at London, Paris, Brussels, New York, and Chicago.

The Jubilee of the Chemical Society of London: Record of the Proceedings, together with an Account of the History and Development of the Society, 1841–1891. London: 1896.

This volume contains a full account of the work of the Chemical Society for 50 years, from March, 1841, when it was founded in the House of the Society of Arts, and a report of the proceedings of the jubilee meetings. Special attention is given to a statement of the various changes of meeting places. The early meetings were held at the Society of Arts, and then at the Westminster Library and Scientific Institution, Leicester-square. The society soon afterwards returned to the Society of Arts, and met in the Adelphi till 1849. For a short time it had offices in the Strand, but in 1851 it rented a house in Cavendish-square, in connection with the Polytechnic Institution. Here it remained until arrangements were made with the Royal Society, and it occupied apartments in old Burlington-house from 1857 to 1873, when it removed to its present apartments in new Burlington-house. A portrait of Thomas Graham, F.R.S., forms the frontispiece to the book.

General Notes.

Post-Office, 1895-96.—The following numbers are those of Post-office deliveries in the United Kingdom for the year ended 31st March, 1896, as given in the last issued report of the Postmast General:—

	Number estimated.	Increase or Decrease per cent.	Avera Numb to ea perso
Letters	1,834,200,000	Inc. 3·6	46·
Post cards	314,500,000	Inc. 0·6	8·
Book packets, circulars, & samples	672,300,000	Inc. 9·4	17·1
Newspapers	149,000,000	Dec. 1·8	3·8
Parcels	60,527,000	Inc. 5·9	1·5
Total......	3,030,527,000	Inc. 4·2	77·2

THE LIBRARY.

The following books have been added to t Library since the last announcement:—

Bamber, M. Kelway.—A Text Book on t Chemistry and Agriculture of Tea, including t Growth and Manufacture. (Calcutta: Law Pu lishing Press, 1893.) Presented by the Author.

Department of Science and Art.—(1) Catalogue Engraved National Portraits in the National A Library. (London: Her Majesty's Stationery Offic 1895.) (2) National Art Library, Classed Catalog of Printed Books—Ceramics. (London: H Majesty's Stationery Office, 1895.) Presented the Department.

Paton, Hugh.—Etching, Drypoint, and Mezz tint: The whole Art of the Painter-Etche (Raithby, Lawrence, and Co., 1895.) Presente by the Author.

Lock, C. G. Warnford.—Economic Mining: Practical Handbook for the Miner, the Metallurgis and the Merchant. (London: E. and F. N. Spor 1895.) Presented by the Author.

Munk, William, M.D.—Life of Sir Henry Halford Bart., M.D., F.R.S. (London: Longmans, Green and Co., 1895.) Presented by the Publishers.

Redwood, Boverton.—Petroleum. (London: Chas Griffin and Co., 1896.) Presented by the Publishers

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Corrections in Mr. Wilkinson's Article, "Gold Mining in Rhodesia" (July 3, 1896).—Page 687, col. 2, line 10, *read* "British South Africa Company's territory;" p. 688, col. 1, line 17 from bottom of page, *for* "west" *read* "east;" p. 688, line 3 from bottom, *for* "Tevakwe" *read* "Tebakwe," and *for* "Belingwa" *read* "Belingwe;" p. 689, col. 2, line 5, *for* "diatas" *read* "diabase;" p. 689, col. 1, line 26, *for* 'mines" *read* "miners."

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CANTOR LECTURES.

APPLIED ELECTRO-CHEMISTRY.

By James Swinburne.

Lecture I.—Delivered April 27, 1896.

INTRODUCTION.

There is probably no branch of industry which is developing so rapidly as electro-chemistry. It might have been thought that this development would have begun ten years ago, as the electrical engineer was then quite able to provide economical steam dynamos. As a matter of fact, inventors have been working at electrolysis and electro-chemical processes for more than half a century, but a large proportion of these were unpractical, as is sufficiently proved by their working out methods involving cheap electrical power when there was no prospect of such a thing. For the last ten years or so, the applications of electricity to chemical manufacture, and to metallurgy, have engaged the attention of a great many very able people, and a still greater number of the class the Americans expressively call "cranks." A considerable time-lag was to be expected, for it takes quite ten years for people to realise that electrical power can be developed at high efficiency and low cost. Even now the average mechanical engineer does not appreciate the value of the electric motor; so it is hardly to be expected that chemical manufacturers can yet all fully realise exactly what electrical power will do. All the same, they have been by no means behindhand, and there are several large electro-chemical works already running in different parts of the world.

Some years ago the difficulty was that the average electrician knew no chemistry, and the chemist knew nothing about electricity; so that there was a sharp line between electricians and chemists. There is, however, a new state of things arising During the last fifteen years a new science may be said to have come into existence. This is chemistry on an engineering basis—that is to say, chemistry is now studied in its relation to the transformation of energy. This study demands almost a peculiar training. It requires a knowledge of mathematics and of thermodynamics, and mathematics is not generally a strong point among chemists. It also needs a knowledge of electricity, and of general physics, and, of course, of chemistry. The result is that what I have called engineering chemistry, or chemical energetics is not the work of the older chemists or physicists, but, with few very eminent exceptions, is largely in the hands of a number of comparatively young men, who are not trammelled by older ideas, and who are specially fitted by their training in chemistry, physics, and mathematics to deal with this subject.

Splendid work has been recently done in physical chemistry and the theory of electrolysis in Germany, and that country has distinctly taken the lead in both theoretical and applied electro-chemistry. But the result is that there is a gradual de-velopment of two distinct classes of electro-chemist. One the purely scientific, who does not know the price of anything, and could not tell a buddle from a jigger; and the other who never heard of the Kupferferrocyanidniederschlagsmembranerscheinungen—I think that word is approximately correct. It is men of the last class that are doing the practical invention, and are getting capital and setting up factories. But the first class must not be regarded as useless. Like all purely scientific men they are providing the raw material for the practical technologist to work up into the finished article for the use of man. It is, however, a great misfortune that the two kinds of knowledge cannot be more often combined in the same man; and the present tendency is towards more complete separation, which is to be deplored.

Electricity is being gradually applied to many branches of metallurgy; and to various processes of chemical manufacture, chiefly inorganic; there are also signs of its development directly and indirectly in the manufacture of organic products. Electricity is also used as a means of getting very high temperatures in the electric furnace, and though in such cases the reaction is generally a mere reduction by carbon, and not electrolysis at all, their description may be classed under electro-chemical work.

It would be clearly impossible to give any account of even the theory of electrolysis, or the practice of it alone in four short lectures. It was, therefore, very difficult to know how to give a short course on such a subject. As experiments are an important feature in the Cantor lectures, and as the only conceivable reason for anyone's coming to a lecture—unless he has to give it—is to see experiments which he cannot see elsewhere, and which cannot very well be described in print, it seemed best to show as many experiments as possible. The subject, however, does not lend itself very well to lecture demonstration, and, therefore, as many experiments as possible—especially new ones—were chosen, and the lectures were arranged and delivered very much to suit the experiments. As these would hardly read well, the printed lectures are different, and include very little of the delivered matter, being practically independent. As just explained, it would be impossible to go over the whole ground, even very shortly; so I will merely touch on a few points that seem to me interesting, without attempting to follow the lectures delivered, or to give any sort of general survey of the subject. Up to now, the Cantor lectures have been not only exceedingly valuable in themselves, but the lecturer has frequently changed into an author, and the series of lectures grown into a book. If it is ever my fortune to develop these lectures into a book, I shall then at least have room to give a more general account of the subject.

COST OF ENERGY.

In most electro-chemical manufactures the cost of energy is of cardinal importance. The cost and heating power of the coal is the most important factor. If coal is taken at ten shillings a ton, and gives half an indicated horse-power hour per pound; and if the combined efficiency of the engines and dynamos is taken at 80 per cent., the coal comes out at 0·18d. per kilowatt hour. In many places coal is much cheaper than ten shillings per ton, without being anything like proportionally worse, so that 0·18d. per Board of Trade "unit" may be taken as quite liberal enough, as far as coal goes. To the cost of coal must be added labour, superintendence, oil, and waste, and the interest and depreciation on the generating plant. These can be covered with a reasonable margin by taking the cost of power as a farthing per kilowatt hour. A great deal depends, however, on precisely what is meant by cost. A farthing per kilowatt hour covers outlay for coal, wages, and stores, and interest and depreciation at low rates on capital an plant. If, however, an engineer were to g out an estimate for the manufacture of som chemical, which was very simple, needing litt more than electrolytic tanks and storage ar packing; and if he found that the vats ar electrolytic department cost, say £16,000 build and £4,000 as working capital; and th the profit after paying salaries, wages, ren taxes, office expenses, and after paying for a energy used at the rate of a farthing a kilowa hour, was £2,000 a year, he would be qui wrong in saying it would pay 10 per cent. T capital in engines and dynamos must be tak into account and added to the other, bringin it up to say £40,000. Then to the £2,0 must be added the interest on the £20,000 generating plant, that is included in the fart ing, say £1,000. The total profit is thus £3,0 on £40,000, not £2,000 on £20,000; or 7½ p cent. instead of 10.

This example is given to show that a goo deal of care is necessary in working out eve the roughest estimates. The great difficul is to know what is meant by cost in each cas If the generating plant belonged to an i dependent proprietor he would not be likely supply energy at a farthing per kilowatt hou He would reckon his prime cost as a little le than a farthing, and would then add on a co siderable per-centage to give his selling pric In central station work the cost of energy enormously greater. This is because t generation does not go on continuously d and night, and because the expenses of di tribution and collection as well as the inco veniences of location come in. The cost energy produced by an electric light station thus no criterion, as the other expenses r up so enormously that the cost of coal burnt full economical load is almost buried under pile of incidental expenses.

Probably the greatest errors in estimati the costs of electrolytic processes are due, n to under-estimating or over-estimating the co of electrical energy, but to not realising t expenses of handling, packing, finishing, perhaps purifying the materials. Other thin have to be considered, such as the dislike the trade to anything new, or apparently ne The word "electric" acts like magic in i creasing the sale of hairbrushes, quack med cines, and a thousand and one things whi have nothing to do with electricity; but the articles are mostly sold to women, or to t more ignorant classes. In commerce, on t other hand, there is an equally ignorant pr udice against anything electric. Electrically anned leather, for example, is regarded with onsiderable suspicion, especially as it is omewhat lighter in colour. Even the packing hould be the same as that of the goods made n the old way. Some day people may realise hat electrolytically-made chemicals are often nore nearly pure than others. This is already ommonly understood in the case of high onductivity copper; but then it is chiefly ought by electrical engineers.

In dealing with the cost of electrical energy, he price of coal has here been taken as the basis. There is abundance of water power, however, in many districts, and we must consider how far that may affect the question of cost of manufacture. It is only too frequently assumed that water power costs nothing, and must, therefore, give electro-chemical manufacture an enormous advantage over older processes. This is very far from the truth, however, and the economy to chemical workers of the use of water power has been enormously exaggerated. I say the economy to chemical workers advisedly, for I do not mean that it does not pay well to utilise water power, but that the advantage is to the owner of the waterfall, not to the manufacturer, except in special cases. An example will illustrate this best. Imagine a chemical district where coal is 10s. a ton, and where there is a large use of electrical power (say) for making caustic and bleach electrolytically. Imagine, also, that there is water power in the neighbourhood. If the owners of a chemical works want power, they will apply to the proprietor of the waterfalls. He will by no means make them a present of as much power as they want; on the contrary he will charge rent; and he will charge as high a rent as he thinks he can get. The chemical makers, on the other hand, will not give a rent that will make the water power as costly as coal, but they will be guided by the least difference, so that the rent asked and obtained will be such that it costs the chemical company the same for water as for steam power. If the turbines and races which we suppose to be put down by the chemical manufacturers, cost about the same as the engines and boilers, and take about the same labour and superintendence as the steam-generating plant, the rent for the water power, apart from the land for the turbines and dynamos, which is a different matter, will be approximately equal to the cost of coal for the same power. Assuming the plant to run continuously, day and night, 1,000 kilowatts generated at 80 per cent. efficiency at 2 lbs. of coal per kilowatt hour, coal being 10s. a ton, comes to £6,500 a year in round numbers, or £6 10s. per kilowatt year. A water power of say, 10,000 kilowatts in such a place thus corresponds to a coal mine whose yearly output of coal is worth £65,000 before it is touched in the mine, and whose supply of coal is inexhaustible.

Suppose, however, that the water power is not in the chemical district at all, but in such a place as, for instance, Norway. The chemical manufacturer may be at some disadvantages there. The district may be inaccessible, and the establishment of works there may involve special difficulties and expenses. In such a case the proprietor of the water power will not ask £6 10s. per kilowatt year, for he has no chance of getting that. He will eventually get some smaller rent, so that it will just pay a new concern to start in Norway rather than England. Still it is the owner of the water power that gets the advantage from it, not the chemical manufacturer.

Whether it will pay to use water power in a given place or not depends on how far the power is an important item in the cost of manufacture. In such cases as making aluminium, carborundum, or calcium carbide, the power is by far the heaviest part of the cost of manufacture; and as carriage is a small matter in these cases, such manufactures will be the first to grow in places which have water power, but which are otherwise inconvenient. In most cases, however, the actual cost of the power is a comparatively small matter, and the inconveniences of being away from supply of raw material and coal for heating purposes, and from the market and the supply of skilled labour, make it inadvisable to use water power, even when it can be obtained at a very low rent. Cases like that of Niagara are peculiar. It seems to be the idea that an industrial centre will spring up around the Falls merely to batten on cheap power. There are not very many industries, electrical or non-electrical, in which power plays a very important part, and in most cases it would not pay to start works in a new locality, even if the power were given, as the drawbacks are serious. Thus, for example, it would not pay a cotton-spinner to start a new works in Devonshire, even if power were given him there, as he could not get operatives there, and he would be completely out of touch with his markets, both for buying and selling. In other cases, the works must be near the raw material, if it is heavy, as in the case of gold mining, or near coal, or near both, as in the case of iron works. In the case of Niagara, it will undoubtedly pay users of electrical furnaces and makers of aluminium to take power from the supply company there, rather than burn coal, as the supply company can always supply power more cheaply than it can be got from coal. Whether it would pay to go to Niagara, rather than to any other falls, depends on the terms offered.

The position of water powers is a little anomalous just at present, because things have not settled down yet. At present the water powers are not fully utilised, or anything like it; and there are very few processes in which power is the factor of paramount importance in determining the cost. At first, therefore, power can be got for such processes at nominal rents, and it is almost correct in such cases to say the power costs nothing. The farthing per kilowatt hour, in the case of coal, however, included interest and depreciation on plant as well as labour and stores. In the case of the waterfall at a nominal rent, the interest on the capital sunk in flumes, races, turbines, and dynamos must also be taken into account. The cost of power will then come out a long way below a farthing, unless the fall of the water is very slight, and there are considerable engineering difficulties. In cases like aluminium or calcium carbide, carriage is of little importance. The bauxite or other oxide of aluminium has to be carried in any case, and if it has to go by sea or rail, it does not much matter how far it goes within reason, provided it has not to be handled on the way. The aluminium or the calcium carbide is so valuable in proportion to its weight, that the carriage of the produce to market is not worth considering. There are any number of waterfalls in the United States, Canada, Switzerland, and Norway which are available for processes of this nature, so it is probable that such processes will be able to obtain water power at very low rents for very many years to come.

Turning now to such cases as, for instance, making bleaching powder and caustic soda by the electrolysis of a solution of salt, the number of waterfalls available for this purpose is comparatively small. Suppose the electrolysis vats have a current efficiency of 80 per cent., and take (say) six volts per vat, the cost of energy comes out approximately £5 per ton of caustic. Of course this cost must be allocated as to the caustic and bleaching powder, as they are not independent products. We may say £2 10s. per ton of caustic, and £2 10s. fo 2·3 tons of bleach, or, roughly, £2 10s. fo caustic and £1 a ton for bleaching powder Even if the whole of this were saved, it woul not pay to start a works in an out-of-the-wa mountain pass, where the carriage of salt lime, and coal for finishing, and that of th finished caustic and bleach, would come to far more than £5 for each ton of caustic made In addition to carriage, superintendence and skilled labour are more expensive in out-of the-way districts. The whole object of life is not to make an income; that is only a means to an end, and a man with anything in him will not exile himself except as a temporary way of making money comparatively rapidly.

The number of water powers at the coast, or in other very accessible places is limited, and there will soon be enough taken up to raise the rent till the chemical manufacturers no longer profit appreciably by it. The result is that in the immediate future water power will not help the electro-chemist except in such cases as the electrical furnace.

At present water powers are sometimes to be got cheap, as the owners having so far got nothing for them are glad to sell outright, or to give a concession for a number of years for a certain income, rather than await the chances of high rents later on, when electro-chemistry is more developed. In other cases proprietors have already very exaggerated ideas of the value of their property, and it is impossible to deal with them.

It is almost needless to remark that if an electro-chemical company owns a waterfall, it is not in any better position than if it rented it. It has merely sunk some of its capital in the waterfall, and the same rent that would otherwise have to be paid should be charged agains the manufacturing account, and credited to the profit account of the waterfall ownership. If the waterfall was bought cheap, owning it may be profitable, but it does not cheapen the electrolysis, as the company might just as well have let their waterfall for a fair rent, and started their works in St. Helen's, or Kalk.

It is needless to say all this is merely elementary economics. I do not carry books on economics with me on a holiday; but if I remember right, it is a simple application of Ricardo's theory of rent.

While on the subject of costs it may be as well to mention an apparent anomaly which often comes up in making estimates or designing new works. Suppose a process is to be worked, which needs a large steam-generating lant, and suppose that on paper the process s capable of yielding an enormous profit, say o per cent., on the capital. It may be safely aid that such a process, in practice, will not ield such a large profit, as all sorts of things vill go wrong, and troubles will arise in unexpected quarters. Let us assume, then, that in ractice even a pessimist, who knows his subect, expects a profit of 25 per cent. to be arned. Then the question arises, what sort f machinery is to be put down? As the ngines are to run day and night, the efficiency f the generating plant seems of the highest mportance, and the first idea is to put down igh-class boilers, with automatic stokers, and riple-expansion condensing engines of the est and most modern types, on the ground hat, as the engines run continuously, the aving in coal is more than equal to the nterest on the extra capital sunk. It must e remembered, however, that the available apital is limited, as, however good the process appears, it is of necessity a large experiment at first. Unless, therefore, the saving by coal will pay at least the same interest on the increased capital as the process will as a whole, it will be better to spend it so as to get a larger output at a lower efficiency. In extreme cases, it may even pay to fit up second-hand marine or other engines at low cost and low efficiency. The same considerations apply to other kinds of plant. In such cases economical working is not so important as it appears at first sight, but freedom from breakdown is of course vital. Old machinery is often very safe from this point of view, if not overworked. When the process is satisfactorily started, and more capital is available, and the profits are falling towards the normal, it will pay to put in the best machinery, and to work at the highest economy, giving the plant a term of many years to repay its extra cost.

While on the subject of costs and estimates, it may be as well to point out another consideration that is frequently overlooked. An electro-chemical process is proposed which is to compete with a large existing chemical industry, and it is assumed that the price will not fall, because if it did fall a little, the chemical manufacturers would fail. The existing steady price of a chemical is such that the badly managed concerns just make it pay, and the well managed works make good profits. The better makers can always lower prices considerably without loss, so that a new mode of manufacture cannot command the market by being able to produce a little cheaper; it can only oust a few of the existing manufacturers. It must be remembered that it will not pay to put down plant for a process that cannot pay interest and depreciation on that plant; but the old makers have already put down their plant, and rather than close as prices fall, it will pay them to write off the whole of their plant as worthless, or rather at its break-up value, and go on, if they make any profit on their working expenses alone, or even if they hope to do so soon. Before a new process can therefore drive an old one out of the market, its profits must at least be greater by the interest, and for some time by the depreciation of the plant engaged in the old manufacture in addition.

THEORY.

But little can be said here on such a subject. For most practical purposes, electrolysis may be regarded as a convenient means of bringing about oxidation and reduction. The words oxidation and reduction are used very loosely by chemists, but the idea is generally clear enough. If we wanted to make it still clearer, we might go so far as to describe oxidation as what goes on at the anode and reduction as what takes place at the cathode. This would give a good idea of the changes meant, and the notion could then be extended to reactions which cannot be, or, at any rate, are not produced by electrolysis.

When we examine the processes employed in commercial chemical manufacture, as well as in the laboratory, we are struck by the fact that by far the largest portion are processes of oxidation and reduction. Nearly all the processes for getting metals consist of reductions. Iron oxide is reduced to get iron. The carbon is then oxidised out in the converter or on the puddling hearth, to get steel or wrought iron. Zinc sulphide is oxidised first, merely to get it into a form to which reduction is easily applicable. The reduced zinc is then again oxidised, to make white paint. The Leblanc process for making soda crystals and bleach is a maze of oxidations and reductions, with a few substitutions thrown in. The pyrites is oxidised into oxide and sulphur dioxide. There are alternate reductions and oxidations of a complicated nature going on in the acid chambers. The sulphuric acid acting on the salt is a substitution process. Generating chlorine from the muriatic acid is an oxidation and reduction process, and the absorption of chlorine by lime may be considered another case. The bleach is then sold to oxidise paper pulp, and frequently to oxidise our linen to a regrettable extent. The salt cake is reduced in the black ash revolvers, a substitution going on also, this reaction being really very complicated, and after that there is only lixiviation and crystallisation. It would weary the reader, or we might include the Weldon process as part of the system, and enumerate more oxidations and reductions. We may, however, imagine the carbonate to be reduced by carbon, to give us sodium; and we now have a system, involving, without the Weldon process, no less than five separate oxidation and reduction processes to split salt into chlorine and sodium. Electrolysis splits fused salt into chlorine and sodium at once, without any other processes or chemicals being needed, and without any waste. The difficulties in electrolysing fused salt are so great, however, that at present the older and tremendously roundabout processes hold the field. The electrolysis of salt solution is more complicated, as sodium is not obtained, and there are a number of small secondary reactions.

For many purposes, all that the electro-chemist—if such a word could be applied to such a man—wants to know is, how much of a compound is decomposed by a coulomb or an ampere hour, and what pressure is needed. Faraday's law gives him one of the data; the other is a different matter, as the pressure needed depends not only on the back pressure of the decomposition vat, but also on the resistance of the circuit. The resistance often depends on the current density; for instance, if bubbles of gas are being evolved from an electrode, they insulate it, except for the thin films of liquid separating them. The result is a very high surface resistance. I have tried the effect of gradually increasing the pressure on lead plates in dilute acid. The pressure and current rise together until something like 3 volts is reached. The current then increases much more rapidly than the pressure, gases being given off in abundance, and between 3 and 4 volts there is a state of things in which a very small difference of pressure produces a given change of current density. The arrangement was used in connection with a resistance in a differential governor and was very sensitive. As many processes, such as the electrolysis of salt solution, involve evolution of gases at the electrodes, it is important to get the most economical results. The mistake is often made in designing vats with the electrodes inconveniently close together with the idea that a substantial reduction of the resistance is thus secured. When there must be evolutio of gas at an electrode the majority of th resistance is at the electrodes, and it generall makes little difference how far the electrod are apart within reason.

Miscellaneous.

MANUFACTURE AND USE OF LACQUE

Lacquer work is the most elaborate and, in man respects, the most interesting of the art product of the East. Like several other arts, it seems t have been introduced into Japan by the Chinese, bu the Japanese have improved on their teachers, an the lacquer ware of Japan far surpasses the fines Chinese specimens in design, delicacy, and finish Lacquer itself is merely the sap of the lacquer tree *Rhus vernicifera*, which is cultivated specially for it production, chiefly between 38° and 37° north latitude When the tree is five years old it is regularly tappe from the beginning of June to the end of October Incisions are made in the bark, extending about quarter of the circumference of the tree, until th wood is exposed. From these a clear sap flows mingled with a very white milky substance, whic soon darkens when exposed to the air, and graduall becomes a dark brown, almost black, colour. Th incisions are first made on opposite sides of the trunk at regular intervals, and as they become filled wit lacquer it is removed with an iron spoon. After thre or four days new incisions are made close to th former ones. This goes on till the end of the season when the tree being covered with incisions has to b cut down. The branches are then cut off, soaked i water, and also tapped by means of spiral cuts. Th lacquer from the branches sets very hard, and i mostly used for priming the ground work.

The quality of the raw lacquer varies with th season, climate, and soil. It is a viscous liquid, of dirty grey colour, covered with dark brown skin where it comes in contact with the air, and mixed with particles of bark and other impurities. It i placed to settle in wooden tubs lined with paper, and the thicker and inferior quality sinks to the bottom leaving the thinner and finer portion above. The qualities are then separated, by decanting, and strained through cotton cloth. The superior quality is stored in open vessels, in order to allow the excess water to evaporate, and during the process assumes a brilliant black brown colour; in thin layers it is a transparent, shellac-like brown.

The further processes to which the lacquer is subjected before use are generally affected by the workman. They consist principally of mixing it with powdered matter, to harden or colour it, and of straining through a specially made, long-fibred paper. A variety of lacquer is made by mixing the pure lacquer with a special kind of oil. This requires no grinding or polishing, and is used as a furniture varnish, showing the grain of the wood through a brilliant transparent coat of yellowish tint.

The celebrated black lacquer is produced by storing the raw lacquer in the open air for a day or two till it becomes brown. The operation is completed by the addition of an infusion of iron filings or nutgall. Some manufacturers use a selection of gamboge or other liquid dye to improve or modify the colour. The manufacture of lacquer ware is an especially tedious and complicated process. The article to be lacquered is generally of wood. The pores of the wood are filled up with a coating of lacquer and alum, or sometimes the piece is covered with tough fibrous paper. It then receives a coat of raw lacquer mixed with some hardening powder. On this another coat of lacquer is placed, each coat being rubbed smooth with clay dust or some other suitable material. A fresh coat is applied and ground smooth with charcoal and water, and the process is repeated until the requisite thickness is obtained. In work of extra quality, the piece is completed by a few layers of the best lacquer, and finally polished with the ash of deer horn. In some varieties of work the surface is primed and painted a bright colour, and then coated with lacquer, to which a certain per-centage of oil has been added. This method is employed in some of the finest work, and dispenses with the tedious labour of polishing the successive coats of lacquer.

The design for the article is now outlined, with raw lacquer for paint, on a sheet of tough paper, from which it is transferred to the object by simple pressure of the hand. The lacquer is then gently warmed, so that the paper may be stripped off. The artist now goes over the outline with a fine hair pencil dipped in lacquer, and the various colours are applied dry with brushes or pads of different sizes, and adhere firmly to the wet lacquer. The mottled gold surfaces so frequently seen are produced by dusting gold flake through a muslin sieve on to the moist surface. This method produces the dead, or *mat*, effects. The more solid and brilliant masses are obtained by the use of gold leaf.

Lacquer on a gold ground is the oldest and most highly esteemed variety, and the warm tone of virgin gold is generally employed. On this surface are produced in relief flowers and foliage, scenes with figures and delicate network, sparkling like burnished carvings. Occasionally blended with silver, the dead gold ground assumes a soft and pearly tone, in powerful contrast with the red, green, and yellow tints in relief. Avanturine, or mottled gold, lacquer ware is produced by the dusting process described above, and is less costly than the first mentioned variety. The gold flake is dusted on several layers of rich brown lacquer varnish, which deadens the effect in proportion to the depth, so that the flakes nearest the surface alone glitter, while the lower portions convey the effect of depth.

The true or black lacquer is employed for all kinds of articles. It is distinguished by the number of its coats and its perfection of polish. The effect produced should be metallic, not pitchy or varnishy. The best work, inlaid with gold leaf, always gives the effect of polished iron encrusted with pure gold.

Red lacquer is almost exclusively a Japanese product. The pure bright vermilion colour is the most usual, and the ornamental work is very carefully executed. Burganté lacquer ware is black lacquer work, in which mother-of-pearl is used to give variety to the gold paintings. Only the most beautiful specimens of shell are employed, and it is used very sparingly, to indicate bamboo stalks, or for microscopic flowers carved in relief. In common ware, whole designs, scenes, &c., are carried out in mother of-pearl shell. Thin plaques of pearl are painted on one side and covered with tinfoil. These are fastened on with lacquer or stuck on the freshly-lacquered surface. As soon as the lacquer is set, the whole piece is coated with black lacquer, which obliterates all the design. This is afterwards ground down with a stone and polished with charcoal. Under this process the pearl reappears brilliantly polished, and the tinfoil beneath has the effect of increasing the display of colour.

The art of carving lacquer is perhaps of Chinese origin. It is mostly done in red lacquer, resembling the so-called Pekin lacquer. Black lacquer is, however, also used. The lacquer is applied thickly to the article, and dries so hard that it can be delicately carved. When finished it receives a coat of varnish by a special process, which is at present a secret of the manufacturers. Besides the varieties of lacquer ware we have mentioned, there are others which do not call for special notice.

The solidity and durability of well-executed lacquer ware is extraordinary, and it will resist the action of hot water, acids, and boiling alcohol. In fact, hot drinks and meat are regularly served up in dishes of lacquer ware. In one instance, a cargo of lacquer ware which remained under water for eighteen months was recovered intact, although the sea water had had considerable effect on the metal locks and fittings of some of the articles. It must not, however, be expected that the ordinary lacquer ware of commerce will stand these tests. It is specially made for export at phenomenally low prices, which entirely prohibit the use of good durable material, and anything like a prolonged soaking in water would probably ruin the best of the ordinary specimens.

The finest lacquer ware is now made in Tokio and Kioto; the cheaper varieties are mostly manufactured in the interior. Very little work is now made of really first-class quality, as few will pay the money for the great amount of extra labour and material required.

Specimens of the old makers are eagerly sought for, and large prices given for them. £100 was asked for a box 6 inches square, and good examples will fetch their weight in gold without difficulty.—*Hardware Trade Journal.*

JEROME-PARK RESERVOIR, NEW YORK.

The Aqueduct Commissioners of the city of New York have now in active progress of construction two important works to increase the water supply of New York City. One is the new Croton dam, designed to increase the size of the present Croton Lake, and thereby impound a greatly increased water supply for the city at large.

From the present Croton Lake two aqueducts—the old one of 1840, the other the new one completed in 1890—run to the city, delivering their water directly into the reservoirs in Central-park. The city of New York has had one policy as to its water supply; it has always worked on the lines of an increase of reservoir capacity by addition, the old reservoirs being preserved. This conservative method has been so fixed, that to-day the proposals to destroy the original reservoir at Fifth-avenue and Forty-second-street are opposed, and we find that for the immediate supply of New York City, in addition to this reservoir, the lower and more recently built reservoir in Central-park has annexed to it the upper reservoir of still more recent construction, and further to the north and west auxiliary reservoirs for the supply of specific districts; but as the case now stands, the lower portion of New York City depends upon the Central-park reservoir capacity. If the bottom of this reservoir was high enough when the water was exhausted to its lowest level a billion of gallons would be available, but owing to the low level of the reservoir, it can only be exhausted to about three-quarters of its capacity before the pressure fails, and the water left ceases to be of further avail, so that the city can only depend upon this reservoir for three-fourths of its capacity, or three days' supply. While it is not probable that any accident would occur to interfere with the aqueduct service, yet there is always such a possibility, and therefore the Central-park reservoir is to be kept filled; an accident or cutting off of the aqueduct's delivery would leave New York provided with only three days' supply of water.

To provide for additional storage capacity for direct use in the city, construction operations are now in progress on what is known as Jerome-park reservoir, in Fordham, in the annexed district.

Here Jerome-park, with its famous old racecourse, on which so many celebrated horses have been ridden to defeat or victory, with a quantity of adjacent territory, has been selected for a reservoir. The ground offers fair advantages in point of elevation and configuration; its vicinty to the city and its situation in the heart of the annexed district make it peculiarly available for the purpose. The area of about 5,800 feet long and 2,800 feet wide is to be surrounded by an embankment, and the bottom is to be excavated until good surface is reached, so as to establish an available depth of 33 feet 6 inches. This will involve a very large amount of excavating; the engineers calculating that there will be nearly seven million of cubic yards of excavation to be made, c which 3,165,000 will be in solid rock.

The reservoir will be bounded on the west by Sedgwick-avenue, on the east by Jerome-avenue, north b Van Cortlandt-park, and south by Kingsbridge-road The embankment is made in earth, and laid in th well known method adopted by the Aqueduct Commissioners in six inch layers, worked down, and rolle with a heavy-grooved roller, and rammed at point which the roller cannot reach.

Throughout the centre of the embankment a cor wall of rubble masonry is carried, which rises abov the water level and descends well below the bottom of the reservoir, in many cases having its foot deepl embedded in rock. Thus the strength of the embankment will consist in the earth, and the dam will b absolutely impervious, which imperviousness wil partly be due to the earth embankment; but in cas of a deficiency in any place in the earthwork, th slightly battered core wall, three feet thick at th top, will be present, and present an absolutely impervious diaphragm. It is so well-known as to b obvious that the smallest leakage through earth i subject to constant increase, and it is such leakag which the core wall is designed to prevent. Th embankment will be 20 feet wide at its top. O both sides it slopes 2½ to 1; it is sodded on the ou slope, and on the in slope is paved and concreted.

It will be seen that it forms a very perfect type o embankment, and a reservoir so made cannot but b impervious as regards its sides. The nature of th country is such that no trouble can be anticipate from bottom leakage, and wherever any weak spot occur concrete laid upon broken stone is to be use to secure absolute imperviousness.

Running approximately north and south, the reservoir has a masonry structure or dividing wal through which the old aqueduct passes. The ol aqueduct is caused to diverge from its course so as t follow the somewhat sinuous line of this structure and from a mile to the north a branch is taken from the new aqueduct, which is carried to the above masonry structure, and follows it to an outlet nea the southern end. A little to the north of the centre of the reservoir, on the line of this structure, is established a gate-house, and near this is a vertical shaft connecting with the new aqueduct (of 1890) and built at the same time. This shaft connection with the new aqueduct of 1890 becomes an important adjunct in providing the requisite connections. From this gate-house six lines of 48-inch pipe radiate; two approximately north-west, two approximately west, and two approximately east. In the gate-house a very elaborate system of connections is provided, so that water may be taken from either right or left hand divisions of the reservoir or aqueducts and distributed to any of the six lines of pipes. Both new and old aqueducts have outlets into the reservoir, also controlled from this central gate-house, so that the new reservoir virtually supplies two reservoirs of the most perfect possible description, which can be operated entirely independent of each other. As regards capacity, about two billion of gallons will be contained, and taking into consideration the level of the annexed district, practically all the water in the reservoir can be advantageously withdrawn for the supply of the city. The delivery from the six 48-inch pipes will be utilised by the Department of Public Works, who control the city distribution.

One plan suggested is to carry a line from the six 48-inch pipes down across the Harlem River to the city, connecting with its principal mains, which in their turn run to the Central-park reservoirs. This would provide for interruption in the supply of the portions of the aqueducts crossing the Harlem River, one over High-bridge and the other by inverted syphon. In addition to the central gate-house, which will be a complicated structure, smaller gate-houses will be provided where the 48-inch lines emerge from the embankment, and at the point 5,000 feet to the north, where the branch is taken from the new aqueduct, a fifth gate-house will be established. For the construction of this branch matters have been so arranged that only twenty-four hours' interruption of water supply will be required to complete the connection between the branch and the original aqueduct, which operation in itself may rank as a minor triumph of engineering.

As the new aqueduct is only partially filled with water, its crown will be broken into, and the gate-house will be built about it in the rock. The branch will be carried up to the aqueduct's sides, and connected thereto, the sides of the aqueduct being reinforced where exposed by temporary masonry laid up against the outside. When all is ready for the connection, there will be nothing to be done but to break down these walls and the sides, when the brickwork will be finished at the corners, all of which will be a comparatively small operation.

The line of the aqueduct structure and the place for the location of the gate-houses were all indicated by the nature of the ground. The high-level of the water will be five feet below the top of the embankment. On the completion of this reservoir, New York will ave about three weeks' supply of water available in it and in the present Central-park reservoirs.—*Scientific American.*

THE COMMERCIAL CONDITION OF ZANZIBAR.

The imports into Zanzibar, including the produce f the Sultan's dominions, the islands of Zanzibar nd Pemba, amounted in 1895 to a declared value of 1,293,646, an increase, as compared with 1894, of 95,965. The imports from foreign countries, ex-usive of the adjacent protectorates and spheres of iterest on the mainland, have increased to the tent of £139,930, which, taken in conjunction with ie fact that the same class of imports in 1894 amounted to £133,535 in excess of what they had been during the preceding year, is a satisfactory sign that this port is becoming steadily, year by year, a more important market for the manufactures and products of Europe and America and of British India. As regards the various articles imported, rice increased by £68,308, specie by £62,683, rubber by £6,164, and coal by £4,014; while, on the other hand, ivory and piece goods have decreased to the extent of £49,830 and £12,992 respectively. Mr. Cave, Her Majesty's Consul at Zanzibar, says that of all foreign countries British India stands first, and the import trade with that country is greater—to the extent of £130,896—than it was in the previous year. The articles that mainly contribute to this advance are rice, specie, and piece goods. Rice, and cotton piece goods, which are the principal articles of food and clothing for the native, represent from British India a larger value than from any other part of the world. The manufacture in India of piece goods for the Zanzibar market is rapidly becoming more extensive; a cheaper article can be obtained thence than from elsewhere, and the freight is less. The advance in specie is probably due to the direct and more frequent service of steamers now running between Bombay and Zanzibar. Of European countries Great Britain takes the first place, but her imports show a falling off compared with 1894 of £5,133. Piece goods and hardware show a decided decrease and this is owing to foreign competition. Of all the imports into Zanzibar that of piece goods is by far the most important, their value in 1895 being equal to practically twice as much as that of any other article. The only countries which supply this class of goods to Zanzibar are British India, Holland, America, Great Britain, and Germany in the order named. The quantity received from Germany need not be too seriously considered, as it is probable that the piece goods shipped at Hamburg are manufactured in Holland, and it is indeed possible that the decrease in the amouut received from the one country may be ultimately connected with the increased quantities imported by the other, but it is a striking fact that whereas India, Holland, and the United States have done a more extensive business in 1895 than in 1894, the United Kingdom has lost nearly a fourth part of this particular branch of its trade. Perhaps the most important class of piece goods imported into Zanzibar is what is known as "grey cloth," a species of unbleached cloth, which is in great demand in the interior of Africa and forms in some parts the only currency. Of this there are two qualities, the better coming almost exclusively from America, and the poorer and less expensive from Bombay. With regard to the former, America was the first to introduce it into East Africa, and she has never lost her hold on the native market, so much so that whatever be the place of its origin this cloth is universally known as "Americani." It is not only however because America was in the field before Great Britain, that her piece goods retain their position; they are undoubtedly of a better quality than what Manchester has hitherto produced at the same price, and are, moreover, free from sizing, a fact which is fully appreciated by the natives, who notice that no shrinkage is produced by washing, and consider, therefore, that in purchasing them they get a better value for their money. Other reasons for the preference entertained for the American article are that the cloth is of stouter substance than that imported from England, and that as the American variety can be depended upon to be always of uniform weight—9½ lbs. per 30 yards—it can be purchased without misgiving by the piece, whereas consignments from other countries have been found to vary, both in weight and width. With respect to the inferior and cheaper descriptions of this cloth, Bombay has supplied an article which seems to have exactly met the requirements of the native, and which has, within the last seven years, almost entirely superseded a similar variety which was at one time imported from Manchester. Another important branch of this trade is in connection with what are known in the local market as "kangas," printed handkerchiefs, measuring about 50 by 72 inches, which form the principal garments of native women. At one time a large business was done in these with both Manchester and Glasgow, the goods received being roller printed, and good in quality and pattern; but of recent years a demand has set in for a cheaper article, and it has been met by the impost by German firms of a common block-printed "Kanga" made in Holland, which has almost entirely superseded the superior and more expensive English variety, although the cloth itself is still supplied from Manchester. The printing of these handkerchiefs is in Holland performed by hand, by a very cheap class of labour, consisting chiefly of old women and children, and Dutch manufacturers are willing to supply different patterns in comparatively small quantities. German imports into Zanzibar consist chiefly of piece goods, groceries, and hardware. Holland sends piece goods, while the principal imports from France are wine and specie. America sends piece goods and petroleum. The exports from Zanzibar, in 1895, show an increase of £103,601 as compared with 1894. Of this increase German East Africa can claim the largest amount, while southern ports have also taken goods to a considerably greater value than they have in previous years. Great Britain, though taking less of the produce of the country by £15,319 than in 1894, still takes the first place among foreign countries. The chief articles received here from Zanzibar are cloves, rubber, ivory, gum copal, and tortoise-shell. British India comes next in order, taking ivory, specie, and cloves. France is third in the order of importance, taking copra and cloves. The principal articles exported to America are ivory and cloves, and the same may be said of Germany, whose imports from Zanzibar were less in value by £15,588 than in 1894. As regards the cultivation and present position of some of th principal products of the islands, the production of cloves during the year 1895 was the larges for many years, being 901,950 lbs. in advanc of that of 1894, and it is satisfactory to note tha during the last year there were three prosecutions an convictions under the proclamation of the Sultan fo the adulteration of cloves. The cloves, which were i these instances imported from Pemba, were found t adulterated with salt, and were seized and publicl burned, and this action has already had a deterren effect on a practice which was becoming far to common. The cultivation of copra is graduall increasing, the owners of plantations probably findin that in view of the very small amount of attentio that has to be bestowed on the growth of the coco nut tree, the increasing scarcity of labour, the absenc of any duty on the commodity, and the low price c cloves, the production of copra is as remunerative t them as that of the last-named article. France take practically the whole of the copra produced, a sma quantity going to Germany and very little elsewhere The production of chillies has declined from 17,73 *frasilas* in 1894 to 16,336 *frasilas* in 1895, a decreas of 46,935 pounds, the smaller demand for this articl being probably due to its inferior quality owing t careless picking and drying. The plant receives bu little attention from the native, who objects to th slight personal discomfort which he experiences i handling it, the result being that it is allowed t grow almost wild in the eastern and less cultivate portions of the island and that only a comparativel small proportion of the pods are picked, and if picke are but badly dried. If more care were taken wit the cultivation and preparation of this useful commodity, the produce of Zanzibar would, in Consu Cave's opinion, bear favourable comparison with tha of other countries. It is satisfactory to note that th foundation for the future production of other tha these staple articles of export has been laid by th formation of a station for experimental cultivation from which when placed under the supervision of European expert, good results are expected to b obtained. Attracted probably by the high price ruling at the present time for vanilla, cuttings of thi plant have been obtained from the Seychelles Islan by a private firm at Zanzibar and also by the Government. In conclusion, Mr. Cave says that it is muc to be regretted that there is no direct line of Britis steamers between Zanzibar and the United Kingdon There is of course the British India line which run between Zanzibar and Aden, and connects there wit the home service of the same company, but the disadvantages attached to trans-shipment, such as th exposure of goods to the weather while waiting to b re-shipped, and the delay which sometimes ensues i forwarding them to their destination, are so grea that much of the cargo to and from London an Zanzibar is sent by the through steamers of th French and German companies, and passengers as rule prefer to travel by one of these other routes. A direct line of larger English steamers would be an additional incentive to the extension of British trade in East Africa.

BICYCLING REGULATIONS IN BELGIUM.

The following new regulations issued at Brussels regarding the circulation of bicycles in that city are quoted in the *Board of Trade Journal* from a report to the Foreign-office from Mr. G. R. de Courcy Perry, her Majesty's Consul-General at Antwerp. These regulations are likely to be introduced also at Antwerp, and at the same time the bicycle tax of 15 frs., at present in force in that city, will be reduced to the same level as that in Brussels, *i.e.*, 10 frs. per annum. The 10 fr. tax will, it is said, shortly become uniform throughout Belgium.

The Communal Council being of opinion that the bye-law of the 29th of January, respecting the circulation of velocipedes, now calls for certain modifications and additions, orders as follows:—

Art. I. The circulation of velocipedes is forbidden on the footwalks, in the park, or in any of the avenues or public walks exclusively reserved for the use of pedestrians or horsemen.

Art. II. Every velocipede shall be furnished with an apparatus for giving notice of its approach, consisting of a bell, the model of which will be determined upon by the Communal Administration. This bell is to be attached to the handle bar in such a position as to be within easy reach of the cyclist's hands. After sunset all velocipedes circulating on public thoroughfares must be furnished with a lantern with perfectly transparent glasses, and placed in front of the machine at a height not less than that of the nave of the forewheel.

Art. III. Cyclists are prohibited from making circuits round carriages, horsemen, or pedestrians, or performing any other evolutions calculated to impede or render dangerous the circulation on any public thoroughfare.

Art. IV. When approaching any carriage or velocipede, cyclists should take the right side of the road, and when passing the same from behind should take the left, at the same time giving notice of their approach by means of their bell and also moderating their pace. Drivers of vehicles and horsemen should bear to the right when approaching cyclists, and should leave them a free passage of at least one metre and a half in breadth. Cyclists must stop when approaching a horse showing signs of restiveness.

Art. V. Cyclists must proceed at a moderate pace, *i.e.*, that of a horse trotting, when traversing crowded thoroughfares, or when turning corners. They are at all times strictly forbidden to proceed at such a pace as to impede traffic or endanger public safety, nor must they form groups in the streets. Cyclists are prohibited from passing across the line of any procession or body of troops marching. In cases of exceptional congestion of traffic in the streets cyclists must dismount and propel their machines by hand. They should act in the same way when passing through the following streets (here follows list of thoroughfares in Brussels having very steep gradients).

Art. VI. Cyclists must not carry children on their velocipedes, nor relinquish the handle bar or pedals whilst in movement. Learning to ride the velocipede is only permitted in such places as shall be determined upon by the municipal authorities.

Art. VII. Every velocipede circulating on the public thoroughfares must be furnished with a number plate as prescribed in Art. I. of the Regulation of December 5th, 1894, of the Permanent Deputation (Députation Permanente). This plate should be affixed in the manner described in the above-mentioned regulation, *i.e.*, in a conspicuous position on the right of the front fork of the machine.

Art. VIII. Cyclists must dismount when requested by the police and give when required all particulars as to their names, addresses, professions, and residence.

Art. IX. The bye-laws and orders regarding the regulation of traffic are also applicable to velocipedes.

Art. X. Any person infringing the foregoing regulations shall be liable to prosecution.

Art XI. The police regulation of the 29th of January, 1894, is hereby annulled.

THE ALIMENTARY VALUE OF WHITE AND BROWN BREAD.

At the Paris Academy's meeting of 8 and 15 June M. A. Girard contended that white bread, made from pure flour, is quite as nourishing as brown bread containing all the bran of the wheat.

"I have already pointed out," he observed, "that an identical proportion of gluten is present in white bread made from flour that has been bolted, so as to leave 40 per cent. behind, and in brown bread made from flour, from which only 25 per cent. has been rejected."

Another objection made to white bread is, that it does not furnish the human organism with sufficient phosphoric acid; but M. Girard contends that the difference is unimportant in favour of brown bread, while, not even in the poorest countries, does bread now constitute the exclusive diet, eggs, milk, cheese, chestnuts, potatoes, and other vegetables supplying a far more important contingent of phosphoric acid than the difference between the quantities contained in white and brown bread.

While physiologists assert that the human organism requires 3·19 grains of phosphoric acid daily, M. Girard has weighed and analysed the daily food of labourers in the poorest districts, and found that it amounted to double the above quantity. He considers the normal bread to be that made from flour that has given up 30 per cent. of corticle, to serve as food for cattle, to be given back to men in the form of meat.

General Notes.

SCHOOL OF ART WOOD-CARVING.—The School of Art Wood-carving, at the Central Technical College, Exhibition-road, South Kensington, has been re-opened after the usual summer vacation, and one or two of the free studentships maintained by means of funds granted to the school by the institute are vacant. To bring the benefits of the school within the reach of artisans, a remission of half fees for the evening class is made to artisan students connected with the wood-carving trade. Forms of application for the free studentships and any further particulars relating to the school may be obtained from the manager.

VENICE EXHIBITION, 1897.—A second International Art Exhibition will be held in the city of Venice from 22nd of April to 31st of October, 1897. The Exhibition will contain pictures, sculptures, etchings, and drawings. Signor Filippo Grimani, Mayor of Venice, is the President of the Exhibition. The total amount of prizes to be awarded to artists will not be less than 40,000 lire. Prizes will be given for the best critical essays on the Exhibition.

PAPYROLITH FLOORS.—According to Cosmos, floors are now being put down at Chemnitz, Saxony, which are non-conductive of heat, have no joints, and do not resound under the foot. They are made of a mass of paper reduced to powder, which, when melted with water, becomes a paste like plaster of Paris, and may take the place of artificial stone, cement concrete, or parquetry, being all in one piece and polished.

RUBBER FROM LAGOS.—It appears from a report published in the *Bulletin of the Royal Gardens, Kew*, that the total export of rubber from the colony of Lagos from January 1 to December 31, 1895, amounted to 5,069,504 lbs., valued at £269,892 13s. 10d. The rubber owes its existence to a wild plant (*Kixia*), which was only discovered in Lagos within the last two or three years. It was found to be new as a source of rubber, although there is now reason to believe that it had yielded some of that formerly exported from the Gold Coast.

GERMAN AMBER.—The production of German amber in 1894 amounted to about 4,400 centners (220 tons), or about 1,000 centners (50 tons) more than in the previous year. By far the larger portion of the above quantity is put out by the two mines of Palmnicken and Kraxtepellen, belonging to the firm of Stantien and Becker, while the smaller portion of about 120 centners (6 tons) only is obtained by dredging and searching the foreshore of the Baltic Sea. The two mines named above, with the home industry, employ about 1,200 persons.

IMPORTS INTO THE TRANSVAAL.—The imports into the Transvaal have risen from £494,000 in 1886 to £9,816,000. The figures for intermediate years are as follows: — 1887, £1,677,000; 188 £2,457,000; 1889, £3,463,000; 1890, £3,699,00 1891, £2,603,000; 1892, £3,499,000; 189 £5,372,000; 1894, £6,440,000. Of the total in ports into the Transvaal in 1895, 61·4 per cent. com from Europe; 16·8 per cent. from Cape Colony; 7 from Natal; 9·4 from the Orange Free State; 2 from Delagoa Bay; and 2·6 per cent. from oth countries (America and Australia).

THE POPULATION OF FRANCE.—The populatio of France now amounts to 38,228,969 persons, a compared with 38,095,150 at the last census (1891 This very slight increase is almost entirely due to th increase of the urban centres. Twenty-four departments show an increase, and 63 departments a diminution of the population; but there are cases wher there is a falling off, taking the department as whole, while the numbers in certain towns or industrial centres in these departments have risen. Thi is the case in the Aube, Charente Inférieure, Cot d'Or, Doubs Gard, Haute-Garonne, Indre-et-Loire Isère, Loiret, Maine et Loire, Manche, Sarthe, Sein Inférieure, and Somme. According to the *Journa des Economistes* the departments where the greates increase has been shown are the following:—Seine Nord, Bouches-du-Rhône, Rhône, Seine-et-Oise Pas de Calais, Meurthe-et-Moselle, Var, Gironde Alpes-Maritimes, and Vosges. The thirteen othe departments in which the increase in the populatio has been less marked are Corsica, Finisterre, Herault Loire, Loire-Inférieure, Marne, Morbihan, Oise Haut Rhin, Saône-et-Loire, Vaucluse, La Vendée and Haute-Vienne. In these departments th increase is under 10,000. In all the other departments a falling off is shown, and this is most marke in the Orme, Manche, Lot, Calvados, Dordogne Gers, Haute-Garonne, Mayenne, Haute-Marne Yonne, Aveyron, Nièvre, Côte d'Or. In five year there has only been an increase in the population o France of 133,819 persons, and the increase, according to all appearances, is chiefly attributable to immigration.

UNITED STATES COINAGE.—It is reported tha 78,330,773 pieces were coined at the mints of th United States during the fiscal year ended June 30 1896, the total coinage reaching a value of 71,188,46 dols. The gold pieces coined numbered 3,584,760 and were valued at 58,878,490 dols. The bulk o the gold coinage was of large pieces, there havin been 2,593,723 double eagles coined, of the value o 51,874,460 dols. Of silver there were 20,424,52 pieces coined, which were valued at 11,440,641 dols Of this amount silver dollars represented 7,500,82 dols., the next largest coinage of silver pieces being o quarters, which aggregated in value 2,005,705 dols. The minor coinage comprised 54,321,484 pieces, wit a value of 869,337 dols. For the six months ending June the total value of pieces coined was 31,846,372 dols.; 22,523,572 dols. was in gold, 8,856,714 dols. in silver, and 466,086 dols. in minor coins.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1897.

The dates fixed for the Society's Examinations in 1897 are Monday, March 22nd, Tuesday, 23rd, Wednesday, 24th, and Thursday, 25th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post-free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

APPLIED ELECTRO-CHEMISTRY.

By James Swinburne.

Lecture II.—Delivered May 4, 1896.

The pressure needed to cause a given decomposition is frequently calculated from the thermo-chemical data given in pocket-books. As a coulomb decomposes a given weight of, say, salt, and as the combination of the sodium and chlorine which produce that amount of salt give out a definite quantity of energy as heat of combination when they form salt, it seems at irst sight that by dividing the quantity of energy by the quantity of electricity we should get the pressure corresponding to the reaction. Broadly speaking the pressure needed to electrolyse follows the heat of combination, but care must be taken not to take wrong data. The thermo-chemical data quoted in books on general chemistry are mostly taken from a our volume book of researches by Thomsen, and are not always quoted intelligently. It is generally necessary to look up the context to ee exactly what the author means. The heat f combination of, say, zinc and oxygen may e found on examination to be the heat of metallic zinc burning in gaseous oxygen. Allowance must in many calculations be made for the elements in compounds changing their physical state. Other reactions have taken place in a solution, a precipitate being formed, in which case heats of solution are involved. In working with data from Berthelot's book allowance must be made for the old notation. In many cases people totally misapply these data. For instance, in calculating the electromotive force of a Daniell cell we are not really concerned with the heat of combustion of metallic zinc in gaseous oxygen, though it frequently figures in such calculations in spite of the fact that oxide of zinc is not formed. These thermochemical data should therefore not be used blindly; and should only be employed by those who really understand what they are doing. Chemical reactions do not necessarily take place so as to give out the maximum energy, however, so these thermo-chemical data cannot fit.

Suppose we have two primary cells; suppose at the temperature of the air they give one volt; imagine them coupled together, back to back, so that there is no current; suppose those cells, like most primary cells, have a temperature co-efficient, so that the electrical pressure given depends on the temperature; suppose that at a certain higher temperature the cells give 1·1 volt; let one be kept at this temperature, and the other at the temperature of the air: we then have 0·1 volt available, and there will be a current backwards through the cold cell. The chemical work is just the same in the cells, except that all that is done in one cell is undone in the other. The capacity for heat of the whole cell is not altered by any changes in the compounds contained in it, as the specific heat of a compound depends only on the elements that compose it. We thus have a simple example of the pressure not being in accordance with the heats of combination, as the heats of combination would give the same pressure for the two cells. We can put a small motor in the circuit of the two cells, and get work done without any chemical energy being used up, as the chemical action is the same in the two cells. As this would otherwise mean perpetual motion, it is clear that the work done by the motor must be accounted for by heat disappearing somewhere in the circuit. The only place this can happen is in the cells. One or both of the cells must therefore be taking a continuous supply of heat from its surroundings and giving it out as electrical power. The cold cell cannot be taking heat from its surroundings, for if it were, and if the heat were converted into power, we need only wrap the hot cell in a non-conducting jacket, and the system would give perpetual motion. The hot cell must therefore be abstracting heat from its surroundings, and giving more pressure than its chemical reactions account for. Let us therefore divide its pressure in two parts, the chemical electromotive force E_c, and the heat electromotive force E_h. We can call the chemical and heat electromotive force of the cold cell E'_c and E'_h, and the temperatures of the cells T and T′, T being the higher temperature. Now the pressure of the hot cell is $E_c + E_h$, and that of the cold cell $E'_c + E'_h$, of which E'_c and E_c are equal. So the difference of pressure is due to the difference of E_h and E'_h. The difference in this case is taken as 0·1 volt, but that is merely an example. This difference, $E_h - E'_h$ is the available part of the pressure for motor or other purposes, and it is due to heat taken in at the temperature T. As in such cases only a portion of the heat is converted into work, namely, $T-T'/T$, the available pressure, which is entirely due to the difference in heat electromotive force, as the chemical electromotive forces cancel out, can be given thus—

$$E_h - E'_h = \frac{T-T'}{T} E_h.$$

Transposing, we get—

$$E_h = T\frac{E_h - E'_h.}{T-T'}$$

If we imagine T to be infinitesimally above T′, T − T′ is dT and $E_h - E'_h$ is dE_h, or dE, as the increase is the same for the whole pressure of the cell. We thus find that—

$$E_c + E_h = E = E_c + T\frac{dE}{dT}$$

This is Helmholtz's equation, put in a way that may be easy to follow. It shows that where a cell or a vat has a temperature co-efficient, the pressure does not follow the heats of combination, but depends on the temperature coefficient in a definite way.

If the hot cell had given less pressure than the cold one, the current would have been in the other direction; but heat must still be taken in at the hot cell, and a portion of it given out at the cold one. If a cell has its pressure higher than the chemical actions account for, it must absorb heat on discharging, and give it out on being run backwards, and *vice versâ*. If a cell has a negative coefficient, its pressure must be lower than the chemical action accounts for; so, if the h cell has the low pressure, it will be run backwards; but the work done by the curren against the back pressure is too small to pe form the chemical work, and the extra hea to be taken from the surrounding matter. may be asked, where the heat is taken up whether at the anode or the cathode? Thoug the locus of the disappearance of heat is no necessarily the seat of the electromotive forc of a cell, this brings us to another questio which though of purely theoretical interest, a far as applied electro-chemistry goes, may b discussed, the novelty of the view taken bein my justification.

SEAT OF THE ELECTROMOTIVE FORCE IN CELL.

There is not any. After so many abl chemists and physicists have been discussin this question for so long it may seem rathe bold to make such a statement as this; but t a great extent the question is rather one definition. It is commonly taken for grante that, say, a point on a wire must be at the sam potential as itself, but this is not necessaril so. Instead of thinking of an electric circui with which we are a little too familiar to b able to see clearly what I mean, let us take magnetic circuit, that of the magnets of dynamo for example. Imagine a "unit pole at one pole piece. Let it move over to th other, the work it does will be the measure the difference of the magnetic potential of th pole pieces. If the pole is still allowed t move, say, along a small hole in the iron, will go round the field magnets to the poin from which it started, and will then mak another tour round the magnetic circuit, an so on. Each time its path is a complete circu which is interlinked with the electric circui that is to say with the field magnet winding The work done on the pole in each cycle 4π times the current turns in electromagnet C.G.S. measure, or $0{\cdot}4\pi$ times the amper turns in the practical system. Imagine th the iron is perfectly permeable; then all t work will be done on the unit pole in crossin the air gaps; and the fall of the potenti across them will be $0{\cdot}4\pi$ times the amper turns. There will be no force acting on th unit pole on its way through the small ho round the iron of the field magnet circuit. will be seen that every time the unit pole goe round it falls $0{\cdot}4\pi nc$ units of potential, so th every time it passes a given place it has falle that amount. In other words any part of th magnetic circuit differs from itself in magnetic potential by $0{\cdot}4\pi nc$. At any point the magnetic potential has an infinite number of values, differing by $0{\cdot}4\pi nc$. If we consider that the unit pole falls a height of $0{\cdot}4\pi nc$ in going across the air gaps, in order to make up for this fall it would have to be raised the same amount on its way through the iron; but we have specially assumed the iron to be perfectly permeable, and there is no force at all on the way through the magnets. The force there really is, due to the iron not being perfectly permeable, is in the same direction as that in the air gap. A unit pole describing a circuit interlinked with an electric circuit thus falls in potential. Its potential is not raised the same amount at some part of the circuit. If it were there would be no difference of potential between the poles. There is thus no seat of the "magnetomotive force," to use a loose term that is fashionable; in other words, there is no sudden rise of magnetic potential in the magnetic circuit.

Now take an electrical conductor, say in the form of an incomplete ring, and imagine the end of a magnet to be moving slowly through the ring, so as to generate electromotive force. Suppose the wire has no resistance, merely for the sake of simplicity, and suppose the magnet pole is large enough to produce a volt at the rate it is going. If a coulomb is allowed to go from one side of the air gap in the copper circuit to the other, it will fall one volt in potential, the fall of potential being measured by the work done, namely, one joule. Ear mark the coulomb, and let it go round the copper to the place from which it started. As we have assumed the copper to have no resistance, no work is done in this part of the circuit, and if there were any work owing to the resistance of the copper, it would be in the same direction as when the coulomb crossed the air gap. If allowed to go in the direction of the electromotive force, the coulomb is always falling in potential. Every time that coulomb passes a certain point in the circuit it falls one volt. Each point of the electric circuit has, therefore, an infinite series of potentials differing by one volt. It might be said that this cannot be the case, because the potential of a point on the conductor is defined as proportional to the work done by a unit quantity of electricity moving from there to the earth, or to an infinite distance. But it can choose various paths, and if it goes round the magnet pole several times, it will add or subtract a volt for each time it goes round. At first sight the analogy between the electric and magnetic circuits does not seem very clear. The moving magnetic pole, however, corresponds with a magnetic current. A magnetic conductor is unknown, but just as there can be a displacement current of short duration, or a convenient current in an electric circuit, so there can be a displacement or convection magnetic current. The moving magnetic pole in this case corresponds to a convection current; if it had been stationary, but had been an electromagnet with increasing excitation, we would have had a magnetic displacement current. If a magnetic circuit with a magnetic current is interlinked with an electric circuit, there is cyclic difference of electric potential round the electric circuit. If an electric circuit with an electric current is interlinked with a magnetic circuit, there is cyclic difference of magnetic potential round the magnetic circuit.

The analogy between the electric and magnetic circuits is not popularly understood as well as it ought to be, and its clearness has been very much obscured by the unfortunate use of the term, "electromotive force," for difference of potentiol or potential, instead of for the rate of decrease of potential. We have thus "electromotive force" as the line integral of "electric force"—a term not much used—and magnetic force remains as the rate of decrease of magnetic potential. Still further confusion has been produced by treating permanent magnetic displacement as analogous to an electric current, and permeability, which is really the analogue of specific inductive capacity, as magnetic conductivity. To make matters still worse, the term magnetomotive force has come in to denote magnetic potential, while magnetic force remains in the legitimate sense of rate of fall of magnetic potential. These absurdities have been approved by international and other congresses and committees, but the so-called work of holiday meetings of people with idle summers should not be taken too seriously. The idea of the interlinked electric and magnetic circuits and their analogy, and of cyclic potential, is fully worked out by Maxwell. Heaviside, however, has developed the subject very fully, making it the basis of his treatment of electromagnetic theory. I do not know if there are any Germans who do not read English as well as an Englishman reads German badly; but if so they will, if I remember right, find the ideas of Maxwell and Heaviside developed by

Föppl, without Heaviside's special kind of algebra. The idea of a magnetic current is, I think, due to Heaviside.

To sum up, in the electric and magnetic circuits the potential is cyclic. A unit charge or pole allowed to move in obedience to the force acting on it falls in potential continuously, and is not raised in potential at any point. The difference of potential is localised by the properties of the electric circuit itself, such as the resistance and the properties of the dielectric, leaving convection currents out of the question for the moment; and as there is no such thing as magnetic conductivity, the difference of magnetic potential is localised by the permeability and arrangement of the different parts of the magnetic circuit, and not directly by the position of the excitation. The engineer will say "The lines of induction cut the wire of the electric circuit at certain places, and must generate the electromotive force at those places, just as in a dynamo the electromotive force is generated in the wires cutting the strong field. This is shown by the force on the wires there." The answer to this is that lines of induction are a mere conventional idea. Even following the idea up it will be found to be impossible to localise the cutting of the conductors by the lines. We can find two successive distributions, and we may assume that lines move, or that a conductor moves past them and has a pressure induced in it. This is mere assumption though. All we can really deal with is the variation of the total induction interlinked with the electric circuit. No conceivable instrument will show where the lines cut the conductor. A voltmeter may be connected in shunt to a part of the conductor and give a reading. That voltmeter has leads to it, and the voltmeter and the leads form a local circuit, and any variation of the total induction through the local circuit gives a voltmeter reading. Carrying a charge on a proof plane, and measuring the work done is the same thing. As to the force on the conductors of a dynamo, that depends only on the current. The force even then acts on the conductor carrying the current, not on the current. Similarly, in a magnetic circuit, you cannot find any effect due to the location of the excitation.

This may at first seem a long digression from the question of the seat of the electromotive force in a cell. But let us carry the idea of a cyclic potential to a cell with two terminals, connected by two pieces of wire to, say, a resistance which, in comparison with that of the rest of the circuit, we can conside infinite. Consider a unit quantity of electricit at the positive terminal of the cell. Suppos the cell gives one volt. Call the potentia at the positive terminal anything, say 100 Follow the charge along the resistant part o the circuit. It does work and falls one volt and gets to the negative terminal. The negative terminal is, therefore, at 99 volts. Seekers after the seat of the electromotive force seem to assume that if the charge goes on through the cell to the positive terminal, the potentia there will be 100 again; but it will only be 99. The potential of the terminals differs by a volt if considered as connected by the resistance, but they are at the same potential considered as connected through the cell. If the charge were raised one volt on its way through the cell, the line integral of the electric force round the circuit would be zero, and the cel could do no external work.

A great deal of work has been done on contact differences of potential and allied subjects but there is room for a fallacy. The difference of potential between A and B is defined as proportional to the work done by a unit charge o electricity going from A to B; but one cannot work with charges of electricity without something to carry them; and if A and B are conductors which may act chemically on the carrier, or on films of moisture, or gases surrounding it, we are not really simply finding the difference of potential of A and B.

If the chemical pressure of the cell is higher or lower than the actual, so that the cell heats or cools on discharging, it might be said there must be something corresponding to glorified Peltier, Seebeck, or Thomson effects (it is difficult to remember which of these effects is which) between the metals and its electrolyte, and between the electrolytes, if there are two. But the algebraic sum of these differences taken through the cell must be zero; so the generation of heat, or its disappearance as a whole, must be regarded as chemical, or in some other way. Someday the theory of ions may be worked out on circuital principles. In the meantime, I will go back to the usual way of discussing dissociation.

DISSOCIATION.

Not so very long ago it was supposed that in aqueous solutions the water conducted the electricity, oxygen and hydrogen being given off in the nascent state. The nascent gases were then supposed to react on the substances in solution, oxidising and reducing them.

Recently, however, as already mentioned, the heory of solutions and of electrolysis has made enormous strides, especially in Germany. The names of Hittorf, Ostwald, Arrhenius, van t'Hoff, and especially of Nernst are more particularly identified with this development.

Too much space has been already given to he theory, or, rather, to one or two details of heory, to leave room for a long account of recent ideas of electrolytic dissociation. The heory is, that when a body is dissolved in a solvent, its molecules are moving as they would be in a gas. The mean free path of the molecules must, of course, be enormously smaller in a solution; and, I believe, that has been put forward somewhere, as an objection to van t'Hoff's theory. Under certain assumptions, however, the figures work out right. If a small quantity of sugar, say, is dissolved in water, and the solution is separated from pure water by a diaphragm, through which the sugar cannot be diffused, water will diffuse into the sugar side of the vessel. If it is closed, water will come in, until a certain pressure is produced. This is the osmotic pressure, and it is found to depend on the number of molecules of sugar per cubic centimetre of liquid. Solutions with the same number of gramme equivalents per litre of different non-electrolytes give the same osmotic pressure, and the pressure corresponds to the pressure they would give as gases occupying the volume of the whole solution. Solutions containing the same number of gramme equivalents per litre also give the same vapour tension, and the same freezing point. Electrolytes, however, have higher osmotic pressures than Avogadro's law applied to solutions would give. This is explained by the dissociation or ionisation of salts in solution. Dissociation is a rather unfortunate term, as it is used for such splitting up as that of ammonium chloride into ammonia and hydrochloric acid when heated, in which cases both the bodies found are ordinary substances. In electrolytic dissociation, for instance, salt splits into sodium and chlorine. The chlorine and sodium atoms are not as in free chlorine and metallic sodium, but are electrically charged, and give up their charges to the anode and cathode. Only part of the salt is dissociated, the proportion not dissociated or ionised depending on the strength of the solution. Thus in a very strong solution very little of the salt is ionised. The term "ionised" is, perhaps, preferable to dissociated, as it uggests electrolytic dissociation as opposed to ordinary dissociation where the compound is not split into electronegative and electropositive radicles. As the solution is more and more diluted, the salt becomes more and more ionised. The electrical conductivity is due to the possibility of convection currents of the ions. The salt that is not ionised does not conduct. The current in the liquid consists of charged ions moving in different directions under the electric force. As the ions come against the electrodes they give up their charges, and are deposited as metals or given off as gas as the case may be. The conductivity of a solution depends only on the number of free ions per cubic centimetre. A very strong solution has very few, so it conducts badly. As the solution is diluted, the ionisation goes on more quickly than the dilution, so that though there is less of the elements of the compound in a cubic centimetre, the proportion ionised is so much greater that the total number of free ions per cubic centimetre is increased, and with it the conductivity. As dilution proceeds the ionisation no longer compensates for its effect, and we finally have a very dilute solution in which, though the ionisation is nearly complete, there are so few ions in a given volume that the liquid hardly conducts. Suppose, however, that we take a given quantity of the salt and dissolve it in a right prism of water of a given length with electrodes at the ends, and measure, not the conductivity, but the conductance from plate to plate; as the liquid is diluted, the increase of cross sectional area of the prism exactly counteracts the decrease of conductivity due to there being less of the elements per cubic centimetre, so that the increased ionisation tells independently. By this method in fact the combined charge carrying capacity of all the free ions in a given quantity of salt is measured, and it increases with dilution as the ionisation goes on, and tends towards a maximum at the point of complete ionisation, which exists at infinite dilution. By making a series of observations the molecular conductivity at infinite dilution, that is under the condition of complete ionisation, is found, and the ionisation, or the proportion of the ionised part to the whole of the salt at any dilution can be found from the conductivity. The results so obtained account perfectly for the osmotic pressure of an electrolyte being greater than that of a colloid or non-electrolyte. After ionisation the separate ions act as molecules, so that a dissolved electrolyte behaves as if there were an extra number of molecules added, corresponding to the ionisation. Electrolytes also lower the freezing points of solutions, and raise their boiling points more than corresponding gramme equivalents of non-electrolytes; but the results are quantitatively right when ionisation is taken into account.

The current in an electrolyte consists of a convection transfer of charges due to the ions moving in different directions under the electric force. They move at different rates under a given electric force. This is a point of some importance in practical work, as it controls the concentration of the solution in the immediate neighbourhood of the cathode and anode. The movement or migration of the ions must not be confounded with electric osmosis, which is a different phenomenon. Suppose we electrolyse a solution of hydrochloric acid. This consists of water, which is very slightly dissociated, and may therefore be regarded as not conducting at all; molecules of hydrochloric acid which also do not conduct, for the hydrogen and chlorine have equal but opposite charges, and as they move together they cannot assist a convection current; and, finally, the solution consists of loose charged atoms of hydrogen and chlorine. They cannot be separated by diffusion as in ordinary cases of dissociation, for as soon as the faster moving ions begin to diffuse into a new liquid their charges alter the potential of the liquids and thus the electric force comes into play, keeping back the fast and helping the slow and oppositely charged ions. For every atomic equivalent of electricity that passes through the cell of dilute acid an atom of chlorine comes off at the anode and of hydrogen at the cathode. There are thus two atoms removed from the electrolyte by the passage of the electric charge of a single atom through the cell. If there were no movement of the ions there would then be a hydrogen atom close to the anode and one of chlorine at the cathode. As soon as there is an excess of atoms of this sort there is a difference of potential between the sides of the electrolyte, and this causes the ions to move across. If they moved equally, for every two atoms of chlorine and two of hydrogen deposited on the electrodes there would be a movement of one atom of chlorine and one of hydrogen in opposite directions across any surface separating the electrodes, and the liquid in the neighbourhood of the electrodes would be equally impoverished as to hydrochloric acid. But suppose the hydrogen atoms move five times as fast as the chlorine, for every six atoms of chlorine and six of hydr gen given off at the electrodes, five atoms hydrogen and one atom of chlorine will pa an imaginary partition in opposite direction The anode liquid will thus be impoverish by five molecules of hydrochloric acid, but t cathode solution will only lose one.

Space will not permit of a fuller account electrolytic theory, and I must pass on practical work, mentioning only a few processes.

THE ASHCROFT PROCESS.

One of the most interesting of the more rece electrolytic processses is the Ashcroft metho of treating the Broken Hill ores. As far as I kno this process has never been fully described i print, in fact, I do not know that it has bee described at all. The directors have very kindl given me permission to explain it as fully as can, so I take the opportunity of doing so.

As is generally known, the Broken Hi mines contain enormous quantities, in fact millions of tons of argentiferous sulphide o lead and zinc. Where this has been expose to the weather for many thousands of years the zinc and lead sulphides have been oxidised and the zinc salts have been washed away The lead and silver are then very easily deal with metallurgically. The exposed and oxidised ore is nearly done now. Although enormous quantities of lead and silver have been taken from the Broken Hill mines, all that has been done, so far, is but a mere scratching o the surface compared with what there is still to do. The sulphide of lead and zinc is, however a very troublesome ore to deal with. The zinc prevents its being treated as a lead ore, and the enormous mass has been regarded as valueless until some process for treating could be discovered. The lead and zinc sulphides are very intimately mixed, so that concentration is exceedingly difficult. Of course there have been endless schemes for the treatment of this ore, and probably every inventor in Australia has devoted some attention to the matter; but until the Ashcroft process was invented, nothing very promising had been brought forward.

The Broken Hill ore may be taken to consist, roughly, of 30 per cent. of lead as sulphide, 30 per cent. of zinc as sulphide, and 25 to 30 ounces of silver to the ton. There is not much gangue.

In the Ashcroft process the ore is first ground—not too fine—and then roasted. This converts the zinc sulphide mainly into oxide. Of course the sulphide can be roasted till practically all the zinc is in the form of oxide, but it is most economical in this case not to roast so far. It will be said that this involves waste of zinc in the form of solution of sulphate, but the zinc at this stage is practically of no value. It pays better to allow a certain amount of zinc to be wasted, rather than to go to the expense of roasting into oxide.

The roasted ore is then leached with a solution containing persalts of iron, and salts of zinc, sulphates, and chlorides. The oxide of zinc in the roasted ore is dissolved as sulphate or chloride, while the iron is precipitated as ferric hydrate. The ferric hydrate is apt to remain in its colloidal form, but the solution is heated and the iron thrown down. The solid matter is allowed to settle, and the solution is run off. The solid matter contains all the lead, and some of the silver, and some zinc. There is so little zinc, however, that it gives no trouble in smelting. The iron oxide is also required for smelting, and would have to have been added in any case.

The solution is led through tanks containing zinc plates or shavings to catch any silver. It then goes to electrolytic vats, and some of the zinc is taken out. The anodes in these vats are iron, so that iron goes into solution as ferrous chloride or sulphate. A diaphragm is used, to prevent the solution mixing. The mixing of the solutions would be fatal to the process, because iron would be deposited on the zinc. This would not only give zinc containing iron, but it would prevent the zinc coming down properly. It is by no means easy to produce a smooth, even deposit of zinc of any thickness; and as soon as a deposit begins to come down badly, it is very troublesome to get it right again. In order to prevent any chance of iron getting into the cathode chamber, the liquid on this side is kept at a slightly higher level, so that there is always a current through the diaphragm which prevents any trace of iron getting in. The liquid from the cathode chamber which has been deprived of some of its zinc, is led to a second set of vats in which more of the zinc is taken out. The solution is then led to the anode chamber first described, so as to take up iron in the ferrous state. The ferrous solution is then led to the last vat, which has carbon anodes instead of iron. This converts the iron into ferric salts, and this solution, which contains ferric and zinc salts, is used for leaching the roasted ore. The process is thus cyclic.

Most people who have had experiences of leaching processes may be inclined to think that there must be difficulty in getting the iron completely thrown down by the roasted ore. The leaching, however, goes beautifully at once, and, after heating to deposit ferric oxide, there is no trace of iron to be found in the solution. It is necessary, of course, to have excess of zinc oxide, to make sure that all the iron is thrown down. Traces of aluminium and manganese salts may find their way into the solution, but that does not matter, as they cannot accumulate beyond a certain amount, as will be explained immediately.

The leached ore and oxide of iron contains a good deal of solution, so that a certain amount of zinc salts is taken with it. As the clear solution is separated from the sludge by decantation, and the sludge is still liquid enough to be run off into settling tanks, it might be that it would pay to save the solution of zinc, but this is not the case. If the solution could be perfectly separated so that none was thrown away, and no new solution was added, the impurities would accumulate until they gave trouble in the depositing vats. A certain proportion of the solution is therefore allowed to go off with the slimes, and the solution is made up with sea water.

As explained already, the roasted ore contains zinc in the form of sulphates, and of oxide. A basic sulphate may for the moment be regarded as a mixture of oxide and sulphate. The circulating system thus consists of a stream of solution which, after leaving the leaching vats, has its silver removed, and then goes through cathode chambers, were about one-third of its zinc is taken. It then goes through anode chambers while it takes up the iron, which in the second set of anode chambers is converted into the ferric state, and the ferric salt is changed for zinc salt in the leaching.

It is only zinc in the form of oxide that is taken up in the ferric solution; that in the form of sulphate goes into the solution without any corresponding precipitation of iron. This zinc is useless, as it cannot be deposited in the tanks. All the zinc taken up as sulphate by simple solution is thus wasted. This is a very curious result, but a little consideration will show that it must be so. The zinc deposited in the vats is, of course, accurately in proportion to the iron dissolved. The vats must be arranged so that the iron anodes have twice the current of the carbon vats, otherwise there would be chlorine liberated, or ferrous salts in the leaching solution as the case might be. This result is easily secured by having two iron vats in series with one carbon cell. Suppose two gramme equivalents of zinc—that is to say, 130 grammes of zinc—are deposited in the cells with iron anodes, two gramme equivalents of iron—that is to say, 112 grammes—are dissolved as ferrous salt; in the next cell, with carbon anodes, the ferrous salt is raised to the ferric state, and another gramme equivalent of zinc is thrown down. For every three gramme equivalents of zinc we thus have two gramme equivalents of iron, and two gramme equivalents of ferric salt act on three gramme equivalents of zinc oxide in the leaching vats. The zinc deposited is, therefore, equivalent to the iron, and is thus the zinc that is taken up by action of the ferric salt on the oxide. If the same liquid always circulated without any being drawn off, the zinc would increase till the solution was saturated as regards zinc sulphate. The zinc sulphate is therefore drawn off, to some extent, with the slime after leaching. It may be utilised by other processes, but as far as this process goes, it is a waste product. It still pays, however, not to trouble to roast the zinc sulphide completely into oxide.

Only about a third of the zinc is removed from the solution during one tour through the electrolysis house. There has always been some difficulty in getting a good, smooth, dense deposit of zinc. It is very apt to come down in a spongy form, and in this case it is practically impossible to deposit it commercially. For that reason many people have advocated the use of alkaline solutions of zincates, such as the solution of zinc oxide in caustic soda. On the other hand zinc sulphate will sometimes give very perfect deposits; and zinc sulphate was the electrolyte employed in the Edison electrolytic meter, where it seemed to work with almost perfect success. The deposition of zinc on a large scale, from the sulphate, has, however, generally given great trouble. In the Ashcroft process this trouble is overcome by the use of a solution containing basic sulphate and chloride of zinc. There is always excess of zinc oxide in the ore, that is to say in leaching, the roasted ore and iron solution are so proportioned that there is more oxide than the iron can deal with. Though the basic salts of zinc are insoluble in water they are fairly soluble in solutions of the corresponding neutral salts, so that the electrolyte really contains basic salts. This seems to make all the difference in the nature of the deposit. Even then the deposit is somewh brittle. New wooden vats will sometimes a something to the solution which makes t deposit come down badly.

The vats are wooden tanks and the cathod are sheets of zinc suspended in cells which a dropped into the larger cells. The diaphrag are made of close texture canvas. The anod are crude wrought iron. It is probable th crude pig iron will do, but cheap wrought ir is at present used. The circulation is arrange so that the current of liquid through the catho chambers is quite distinct from the ano circulation; the liquid in the cathode chambers being kept at a little higher level a already explained, so as to make sure that n iron gets into the cathode cells. For th carbon electrodes either plates or rods of th same material as electric light carbons a used. This material is, of course, expensiv but it is not practicable to arrange for reto carbon, or any other cheap substitute, as, to g a reasonable output from a given area of a v house, the vats have to be deep. The circulation systems make it difficult to have sets shallow vats one above the other. The carbo is attacked, to some extent, but the corrosion i small, as there is plenty of chloride availabl The oxidation has to be carried a trifle furthe than would suffice for the complete conversio of the ferrous into a ferric salt, so that a trac of chlorine or hypochlorite is formed. Thi oxidises any traces of ferrous salt that ma not have come into contact with the anodes. I is most important to have no ferrous salt in th leaching vats, as they are not precipitate by zinc oxide, and would find their way int cathode vats, and spoil the deposit.

This process is the invention of Mr. Edga A. Ashcroft, and is now owned by the Sulphid Corporation (Ashcroft's process) Limited, wh are commencing to work it in Australia. Thi company also owns a block of the Broken Hi mines, so that they have an almost unlimite supply of raw material to work upon. Th process has already been worked on a manufacturing scale, and works are now bein started in Australia and the United States

Miscellaneous.

CHROMO-LITHOGRAPHY IN CERAMICS

The following particulars respecting the use o Chromo-lithography in the Pottery Trades are take from an article in the *Pottery Gazette*:—

Quite recently, comparatively, the adaptation of romo-lithographic printing to ceramics has been ccessfully attempted. In France, Germany, and ngland, there are quite a number of manufacturers lithographic decorations for application to earthenare and china. Line engraving, which, along with inting, has long held the first position in vari-loured decoration, has now a very serious and owerful opponent, and the "printers" and "fillers " have before them the prospect of severe and etermined competition. The principal features of ramic chromo-lithography are much the same, and e method is little changed from its first essay, cept in the elimination of technical difficulties d the introduction of labour-saving devices.

The earliest form of the application was that of yramic colours printed on a specially-prepared aper; this paper, when used, was smeared over ith a gummy "size;" the article to be decorated we speak only of glazed ware) was also coated very hinly with the same size, the paper was cut up into uitable pieces slightly damped, and carefully and rmly pressed to the ware. A short soaking in ater completed the operation; the paper was easily emoved, leaving the colour fixed on the ware and eady for firing. There were considerable difficulties this manner of using; the "size" sometimes was usty, the workpeople were careless, and much nnecessary time was lost, so that in the first case margin of stain was visible round the ornament, nd in the other the ornament was deranged, broken, nd often destroyed. Little by little these drawbacks vere removed; first the application of the "size" y the workpeople to the paper was abandoned, the aper being supplied ready sized. It was then only ecessary to "size" the ware; then was found out a nethod by which the sizing of the ware could be lone without; then, last of all, the somewhat tireome and dangerous soaking in the water was bolished. And now it is only necessary to place he sheet, cut to the proper form, upon the ware to e decorated, press it firmly down with a damp ponge, quickly remove the paper, and the ware is lecorated. In the very best productions there is bsolute immunity from any danger of the margin of aper round the decoration staining the glaze. Our eaders will, of course, understand that the decoration, being printed on sheets of paper, has to be ut up for use, and it is impossible to cut exactly he decoration out of the sheet; there is, consequently a margin of unprinted paper round the decoration. The next great step will be the production of the "chromos" on thin or common printing paper. So far, it has been obligatory to use a somewhat thick and stiff paper, which does not always lend itself very easily to the decoration of any pieces irregular or sharply curved, or forms having deep retreating angles. This difficulty will, like the others, no doubt be overcome.

In Germany there has been considerable success, with a somewhat different application of the same principle—and very ingenious it is. The paper to be used is coated with a fine film of a gelatinous character, upon which the colours are printed. In use this, well damped, is laid upon the ware, and the paper is slipped away, leaving the film of gelatine or collodion upon the ware. This system requires very delicate and dexterous handling. Another method adopted by an English firm is the use of a thin facing paper with a tough or strong back, the backing easily separating from the face; this method, we have reason to believe, will prove one of the most, if not the most, successful methods so far in practice.

The great advantage of the chromo-lithographic decoration lies in the high excellence of the ornament that may be used and the purity of the colouring that be attained. Given a design by a first-class artist, let it be reproduced by one of the best houses in the ceramic lithographic trade, and you are certain to have exact copies, with nearly all the delicacy and tenderness of the artist's original handiwork.

Printing and filling in has always been liable to the danger that the work would be very unequal. Too often the samples sent up to the showrooms have been most carefully touched up and worked by one of the head decorators, and the orders have been executed in bulk by careless and not over-competent girls or lads.

This great evil the ceramist lithographer avoids, and, except those errors to which humanity is always liable each piece may be made an exact reproduction of the original pattern and be quite equal to the samples shown by the salesman; this, in itself, is no slight gain. Up to the present the chromo-lithographic work is only used for the production of enamel or on-glaze decoration. So far, the line engraver and the painter hold their own in under-glaze or biscuit decoration; but, little by little, essays are being made and methods made good by which we feel assured that the many and great difficulties besetting the use of these colour prints to the unglazed ware will be overcome, and that the future of the chromo-lithographer will be as much or more applicable to biscuit decoration than at present it is to glazed ware. No doubt some time may elapse before really high-class underglaze chromos are produced, but already we have seen some attempts that appear to possess the germ of a brilliant success. The great difficulties, so far, are first in the character of the unglazed ware, or, as we know it in the Potteries, "biscuit." The rough, strongly absorbent surface of the biscuit ware, the least informed will at once see, is totally different from the polished non-absorbent surface of the glazed ware. So that the methods and materials used in the one case are quite unfitted without great alteration to be used in the other. But a still greater difficulty has to be overcome, and one that will tax the cleverest intellects engaged in the work. It is this: In printing from engravings, the "print" is really a relatively thick line of colour; just in proportion as the engraver cuts deeply into the plate, so is the quantity of colour "taken up." Now "underglaze plates" are cut much more deeply than "enamels," and if the "transfer" or printed paper is examined under a microscope, the underglaze prints are seen to consist of raised, as we previously said, relatively thick ridges of colour, laid with the point of the ridge uppermost. It is this depth or strength of cutting that enables the underglaze prints to produce their strong patterns; for, owing to the action of the glaze, if only a thin film of colour as is used in chromo-lithography were applied to the ware, the decoration would be so faint as scarcely to be seen.

Of course, there are a few colours so strong in staining power as to produce a powerful effect, when only traces of the colouring material could be found. But the range of these colours is very limited, nor is there reason to believe that the colours would prove in the present condition of taste very attractive. All the other difficulties—and there are numerous other technical troubles are nothing—as compared to the "fence" just described. The successful manufacture of underglaze chromos will undoubtedly produce a revolution in which it is very possible that at first the engravers would suffer more perhaps than any other branch. The printers, too, would be hurt. As for the transferers, they would simply have to change their transferring, for the work itself would still have to be done. Great improvement, too, would come about in the character of the decoration, though too much must not be expected at first. It is unquestionably true that the chromos now in the market, with the exception of the productions of an eminent Staffordshire firm, are wretched in the extreme. The German lithos are shockingly bad—bad in colour, bad in design, and bad in adaptation to the ends in view. We may rely upon it then that chromo-lithography has come to stay, and the potters who take up with spirit the use of these prints will be the first to reap the benefit. The French porcelain makers have already done so; excellent in design, of sterling workmanship, their chromo-lithographic printed ware has had and is having a great vogue. The German makers are doing their best to follow them, and the trade in the "transfers" both in France and Germany is already very great.

Our potters have not in the past been behindhand in maintaining their position, and it is to be hoped that they will not let contempt for foreign ideas influence them in this. Our special branch of commerce can afford to lose no opportunity of advancing; our old and unquestioned superiority is being vigorously assailed. All that skill and science can do ought to be brought to bear upon our work.

THE ECONOMIC CONDITION OF CRETE.

It is only necessary to glance at a map of the basin of the Mediterranean to appreciate the great commercial advantages of the position of Crete. At the extreme south of Europe, it is on an important commercial route between Europe, Asia, and Africa, and seems called upon to become the principal entre of the trade of these quarters. It is more than 2, years ago that Aristotle signalised it as the natu intermediary of the exchanges of the eastern Medit ranean. It is an island measuring not less than kilometres (kilometre = ·621 of a mile) long, a with a breadth attaining, in certain places, 60 ki metres. Its superficies is 8,000 square kilometr It is about 51 miles to the south-east of the Mor and about 95 miles from Asia, but it is connect with these two continents by a series of small islan The villayet of Crete is divided into five governme —Candia, Canea, Rethymo, Lassithi, and Sphak each subdivided into a certain number of arrondis ments. It is governed by a *Vali* or governor-gener nominated by the Porte, assisted by a deputy-govern or counsellor, known as *Mouchavir*. The provinc are administered by governors, the arrondisseme by commissaires, the communes by a mayor, and municipal council elected by the people. There is national assembly, composed of 80 deputies— Mussulmans and 49 Christians. This assembly elec the ten members of a general administrative counc whose duty it is to assist the governor-general, t members of which are composed equally of Mussu mans and Christians. There is, in addition, a pr vincial council to assist each provincial governor. A official documents are written in the two language Greek and Turkish. M. Daniel Bellet, in a rece communication to the *Moniteur des Intéré Matériels*, says that in the various civil and crimin courts, where the proceedings are conducted in t Greek language, the judges, who are nominated by t national assembly, are composed equally of Christian and Mussulmans. As regards the Cretan population it amounted, according to the returns of the las census, which was taken in 1887, to 294,192 persons This represents a population per square kilometr greater than is to be found in Turkey in Europe or i Greece; but the fact remains that Crete is not s densely populated as formerly. Savary affirms tha in ancient times it did not contain less than 1,200,00 inhabitants. Under Byzantine rule, the populatio fell to 900,000; in 1859, Christovoulidis estimated i at 302,750 persons. This diminution in the numbe of inhabitants is not an index of a favourabl economic condition; it is no longer the Crete of th hundred cities of Grecian antiquity; the large town have now disappeared, and given place to som half-ruined village. The census returns referred t above, show that persons engaged in trade an ihdustry only represent a small proportion of th total population, while those engaged in agricultur do not exceed 49,000. This latter fact is the mor surprising as the soil and climate of Crete are eminently favourable to the growth of nearly every description of crop. In the plains, as well as i the mountains, the temperature is never extreme, i rarely exceeds 32° Cent. in summer, and from the month of February vegetation commences to cove the ground. Nearly every variety of tree can be ltivated in the island. Unfortunately, the inhabitts do not derive as much advantages from the ndition of the soil and climate as, with very little ouble, they might easily do. As M. Rosseels, the elgian Consul, says, agriculture is in a deplorably ackward condition in Crete. "The ignorant easant has no spirit of initiative, and only uses he most primitive tools and the most defective ethods of tilling and cultivation." For want of little care, the earth does not yield so well as it ight, and taking the olive crop for example, it is equently found that a year of abundant crop, which the staple product of the island, alternates with ne of failure. All this would be altered if more erfected and up-to-date systems of cultivation were dopted, and greater facilities were offered for the eans of transport. The cultivation of barley is retty general throughout the island, as this crop onstitutes the food, not only of the peasants, but lso of horses and mules, and yet the quantity roduced is not sufficient to meet the requirements of ome consumption; in fact, the wheat and barley ow produced does not much exceed that yielded in 860. The natives would find in the carob tree an easy ulture, and a very remunerative one, as locust beans re in constant demand in European markets. The ultivation of the olive, as mentioned above, is the ost important in the island, and it ought to be a ource of considerable wealth; but insufficient care nd attention appears to be devoted to the trees, with he result that the crops are deficient. Moreover, he methods of extracting the oil are primitive in the xtreme; and while it is true that some mechanical resses have been introduced, the general system ppears to be to press the olives under the millstone, nclosed in goatskin coverings. As the natives only ollect the fruit when it has fallen from the trees, it s nearly always defective when pressed, and the esult is that the oil is only fit for lighting purposes. Formerly, the residuum of the olive, after pressing, was always thrown away, and it is only lately that it as been utilised. From the vine, as well as from the olive tree, great profits might be obtained; at the present time, they yield a revenue of some £100,000 annually. But then, again, the neglect in the methods of cultivation, and the system of wine making, have a very prejudicial effect on this industry. There is another article, to which attention might profitably be directed by the natives, and that is, perfumed honey. As regards sericulture, this is far from being in the position it was some years ago, and this notwithstanding the fact that the mulberry tree abounds throughout the island. Finally, as regards industry generally, as distinct from agricultural industry, it may be said to be virtually non-existent; the only article of any importance produced is soap. Glancing at the foreign trade, it is found that while this amounted in value in 1855 to about £1,040,000 equally divided among imports and exports, at the present day, according to M. Stavraleis, formerly Director of the Customs, it amounts to between £2,000,000 and £2,400,000. Vast quantities of rice, flour, barley, and wheat are annually imported, and yet all these articles could be produced in the country itself. Salt, again, is imported to some considerable extent, although the salt mines of Touzla abound with this article.

THE MERCANTILE MARINE OF AUSTRIA.

The mercantile marine of the dual monarchy is chiefly represented in foreign waters by two great steamship companies, namely, the Austrian-Lloyd Steamship Navigation Company, and the Royal Hungarian Steamship Company, "Adria." Statistics relative to either of these undertakings are therefore, says Consul-General von Schoeller, interesting, as indicative of Austro-Hungarian trade with European and trans-oceanic countries. The operations of the two companies are confined within comparatively clear limits, for whereas the service of the Adria line mainly involves western ports, those of the Lloyd line principally extend to the East. Communication with Brazil, however, is maintained by both companies, that is to say, by the Lloyd boats from Trieste, and by the Adria vessels from Fiume. In virtue of a mutual understanding between the two companies, competition—so disastrous to similar undertakings in other parts of the world—has been avoided in connection with the traffic to Brazil; and it has been found possible to increase the sailings of the boats so that eighteen voyages to that country are now performed annually from the ports in question. At the end of the year 1895, the fleet of the Austrian-Lloyd Company consisted of 75 steamers, several of which were exclusively employed in the regular service to India and China. The number of voyages made by the Lloyd boats during the year reached a total of 1,220, of which 287 were to the East and Mediterranean, 197 to the Black Sea and Lower Danube, 36 to India, China, and Japan, 9 to Brazil, 517 to the Adriatic, and 174 to miscellaneous ports. Within the period specified, 276,034 passengers were conveyed by the boats of this line. The cargoes amounted to 755,678 tons. At the close of last year the Adria Company owned 25 steamers of the most modern construction. During the twelve months ended December, 1895, 125 outward bound vessels belonging to this line, conveying 128,954 tons of miscellaneous merchandise, were registered at Fiume, whilst the arrival of 163 Adria boats, with cargoes amounting to a total of 57,292 tons, was reported. In addition to the regular service between Fiume and the Adriatic and Italian ports, the boats of this line likewise undertook a number of voyages to North American, English, and German waters. The extent of the traffic accomplished by these two companies during the past year can thus be estimated, and in presence of the depression brought about by keen competition that prevails among navigation companies throughout the world, the above figures furnish a proof of the enterprising spirit in which the two Austro-Hungarian undertakings are conducted.

EDUCATION IN RUSSIA.

The question of the foundation of a university in the Caucasus appears to be attracting a good deal of attention in the Russian press, and the *Gazette de St. Petersburg* has lately published some interesting particulars relating to the condition of public instruction in that region of the empire. Northern Caucasia comprises the provinces of Stavropol, Térak, Kouban, and the Black Sea, with an area of 203,671 square verstes (square verste = ·44 of a square mile), and a population of 3,081,755 inhabitants. Transcaucasia comprises the provinces of Tiflis, Koutaïs, Baku, Elisabethpol, Erivan, Daghestan, and Kars, with an area of 205,247 square verstes and a population of 5,074,415. As regards secondary education there are in Northern Caucasia three *gymnases* for boys, with 1,335 pupils; two *pro-gymnases*, with 198 pupils; four professional schools, with 1,036; one normal school, with 75; five *gymnases* for girls, with 1,798; and 24 private establishments, with 1,015 pupils. Establishments under ecclesiastical *régime*, for secondary education, comprise one orthodox seminary, with 245 pupils; four orthodox religious schools, with 623; two diocesan schools for young girls, with 479; 415 parish schools, with 14,969; 20 schools connected with the Society for the Propagation of Christianity, with 1,837; and four Mussulman schools, with 50 pupils. There are also eight Armenian parish schools, with 795 pupils. Primary education comprises 581 establishments, with 41,651 pupils; and, finally, there are four schools connected with the institution of the Empress Marie and the military administration. As regards Transcaucasia, secondary education is represented by six *gymnases* for boys, with 2,805 pupils; one *pro-gymnase*, with 219; four schools (professional), with 1,605; three normal schools, with 208; six *gymnases*, for young girls, with 2,872; five *pro-gymnases*, for young girls, with 605; and 75 private establishments, with 3,932 pupils. As ecclesiastical establishments for secondary education, there are altogether 2,699 schools, with 42,878 pupils. Primary education in Transcaucasia comprises 426 establishments, with 32,970 pupils. There is, therefore, in Northern Caucasia one public educational establishment to every 2,859 inhabitants, and in Transcaucasia the proportion is one in 1,577. It is stated that the number of educational establishments in Caucasia are quite insufficient for the needs of so vast an extent of territory.

General Notes.

TRANSVAAL GOLD PRODUCTION.—In 1886, the output of the gold mines in the Transvaal was only 10,032 ozs. In 1887 it had risen to 48,940 ozs; a amounts from 1888 to last year are as follows 1888, 279,600 ozs.; 1889, 430,800 ozs.; 18 540,360 ozs.; 1891, 835,516 ozs.; 1892, 1,289,498 oz 1893, 1,575,397 ozs.; 1894, 2,265,853 ozs.; 18 2,509,851. In 1895, the mines of the Rand e ployed 6,807 white men, receiving a total £1,173,080 in salaries, and 50,648 non-Europea who were collectively paid £1,823,328.

INDIAN MICA TRADE.—It is reported in t Indian papers that in view of the great developme which has taken place in the mica trade, the Mad Board of Revenue has resolved to recommend t discontinuance of the system under which licens for prospecting and mining for mica are at prese issued, and the adoption of the Government of Inc rules in their entirety. All applications for prospec ing licenses with regard to which licenses have n actually issued, have been ordered to be rejected, t applicants being informed that they must produ certificates of the approval of Government und Section 10 (1) and 11 (3) of the Government of Ind rules, and deposit a sum of Rs. 500 as security.

PRODUCTS OF THE BLOSSOMS OF THE ORANG TREE.—In their natural state the products of th blossoms of the orange tree serve to flavour drink sweetmeats, &c. When distilled they yield two ve much esteemed products in Italy, the orange flow water, or *acqua nanfa*, and an essential oil, calle *neroli*. Moreover, when candied, they form a ver delicious sweet, much in vogue in some regions i Sicily. The orange flower water is made of equal po tions in weight of blossom and water, which yield, o an average, about one-fifth of the combined weight c water and flowers, and *acqua nanfa*, plus about six o seven decigrammes per 100 kilogrammes of essentia oil, that is, from ·0006 or ·0007 per cent. Notwithstanding the abundance and excellent quality of th raw material, the best manufacturers of orange flowe water are to be found outside Italy. In Franc great quantities of this water are manufactured, a well as a spirit called *petit grain*, which is produce by a distillation of the leaves. As to candied sweets made out of the blossom, these are said to be mor wholesome, as well as more palatable, than man other productions of the confectioner's art. Th flowers are, in the first place, selected with care weighed, and immersed in cold water for twenty-fou hours, after which they are dipped simply in cold water, re-washed in cold, and finally spread out on a linen cloth or sheet to dry. When completely dry they are laid out in low, wide dishes, each flowe separate from its fellow, and are then sprinkled with double their weight in sugar, administered at intervals during a period of eight days. During this same period the flowers are frequently moved and kept in the shade, and, at the expiration of the term, they are once more placed in the sun, whose rays dry them completely.

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CANTOR LECTURES.

APPLIED ELECTRO-CHEMISTRY.

By James Swinburne.

Lecture III.—Delivered May 11th, 1896.

Removing Tin from Scrap.

As sheet tin has from 3 to 5 per cent. of pure in, it is clear that if all the scrap could be ollected and have its tin taken off, the process ould be very valuable. Tin is a very expenive metal, worth, say, £80 a ton. If scrap tin worth £1 a ton, £100 worth would contain 240 worth of tin, and the iron or steel would e worth considerably over £100. The presence f tin makes scrap tin useless as iron, but if it completely removed the scrap can be worked p into good quality iron. My attention was pecially attracted to tin by an inventor who ame to me with a patent for stripping it. As ie patent he owned seemed useless I worked ut another process. This was not electric, nd consisted in dipping the scrap in baskets ito fused caustic. If old tins were used this lso melted out the solder, and corroded labels nd varnishes so as to get at and remove the n under them. The resulting stannate of soda as to be sold in that state, as it is a marketble chemical. The scrap coming out of the ised caustic had a good deal of the caustic icking to it. It would, on a large scale, ierefore be washed in successive baths, getng weaker and weaker and ending in water; ie liquid being gradually moved up into the sed vat to replace that removed as stannate. y this means the expense of evaporating down l the caustic that adhered to the tin could be ept down. This process works fairly well, ut it is difficult to get the caustic to take up iough tin. The stannate thickens it very iickly, and the resulting mixture never contained enough stannate to be a commercial article. The tin could be easily removed from the caustic by electrolysis and came down well.

This process seemed fairly promising, but at this stage it was found it had been tried before. A company had been formed to work it. Whether that company is now flourishing or not I do not know. As a matter of fact, the process is probably quite old, as it is fairly obvious, and the skinning of scrap tin has exercised a great fascination for inventors for years.

As it was of no use going on with an old process another method was sought. Acid electrolytes attack the iron as well as the tin, and were therefore out of the question. Curiously enough, if sheet tin is used as anode in caustic soda solution, the tin does not go into solution; oxygen comes off. I had tried a number of experiments in 1882, with sheet tin as backing for peroxide plates in alkaline solutions, for secondary batteries. If sheet tin is boiled in caustic lye the tin is not attacked. If clean iron is dropped in, bubbles of hydrogen come off the iron, and tin goes into solution. Strangely enough, however, this process does not act, because very soon the clean iron gets coated with tin, and the action stops. It is very odd that tin should be eaten off one piece of iron and then deposited from the solution on to another piece. This gave the key to the electrolytic process. All that is needed is to heat the caustic bath. The anode no longer gives off oxygen, and the tin is stripped off perfectly and deposited nicely on the cathode.

This process seemed perfectly successful; the next thing was to try it commercially. There are supposed to be thousands of tons of scrap tin wasted every year. It is said to be largely used for mending roads. When we tried to get it, none was forthcoming; and it seems as if the whole idea of there being an important industry in the recovery of tin from scrap is erroneous; the difficulty is to get the scrap. Makers of large tin goods sell their clippings to people who do smaller work, and, finally, the scrap is distributed in such a way that it cannot be collected profitably. The recovery of tin and lead from old cans might be carried on on a very small scale by corporations, but it is questionable if it would pay, owing to the quantities available. This is an illustration of the principle that the great difficulty of the inventor is to discover a long felt want.

ALUMINIUM.

It would be of little use, even if there were room for it, to write a long description of the manufacture of aluminium by the various electrical processes, as full accounts of the works at Niagara, and to some extent of the Swiss and French, as well as the English works, have frequently gone the round of the technical journals.

It is very difficult to know what place aluminium will ultimately take in commerce. It is first to be a marvellously strong, light, and cheap metal, practically indestructible, and combining all the good points of all other metals; then it is run down as being soft, treacherous, easily corroded, and only useful in a few overrated alloys. The truth of course lies between these extremes. It is now becoming more generally realised that aluminium has really a very great affinity for oxygen, even at ordinary temperatures. The only reason why it does not combine with the oxygen of the air quickly enough to catch fire seems to be that the coating of oxide formed is very adherent and hard, and protects the metal. At the same time it is exceedingly thin, and so transparent that the metal shows a beautiful polish, though the surface is really covered with a crust of alumina. The presence of this thin crust is shown by the difficulty of getting solder to take on to it. The coating of alumina also makes it difficult to make electrical contact with aluminium unless enough force is used to abrade the metal and expose a new surface. I have utilised this property in connection with the telephone used as a galvanometer in a Wheatstone bridge or potentiometer. The telephone circuit is made and broken by scraping a wire over a piece of sheet aluminium. This is far more easily heard than the scraping of a wire over the teeth of a file, or anything of that sort. No doubt the copper wire only occasionally breaks through the coating of alumina, and makes a short contact which is soon absolutely broken by the coating of insulating alumina again. If mercury is placed on aluminium, and the aluminium scraped so as to expose a clean surface to the mercury, the mercury amalgamates it. The amalgam, however, cannot protect itself by an adherent coating of alumina, and the oxide forms in light growths of fluffy alumina. If a drop of fairly strong amalgam of alumina is left exposed to the air, the oxide will grow from the surface of the mercury into a thing like the "Pharoah's Serpent," which children make by burning sulphocyanate mercury, when their parents are foolish enou to let them. Caustic alkali, or any acid th dissolves the alumina will corrode aluminiu Another old experiment which shows the coa ing of oxide, is due to Farmer, who fused piece of aluminium wire by means of an elect current, and found it kept its form as a pe fectly flexible and mobile conductor, whi could be deflected by a magnet, and so on. (pricking the wire with a needle the melt aluminium ran out from the inside. This e periment shows that even melted aluminiu which appears beautifully bright and remai clear like silver, is really protected by a surfa film of alumina.

The action of dilute acids, such as nitric ar sulphuric, is very curious. Though aluminiu does not deposit from the nitrate or sulpha in an electrolytic cell, hydrogen coming instead, it is not at all quickly dissolved dilute acid. I tried to make use of this pr perty in an electrolytic meter for alternatir currents. Two plates were to be employed dilute acid, the aluminium going into soluti at the anode during each half period, witho being deposited at the cathode. No sample aluminium that I could obtain was acted upo little enough by the acid when there was current, for such a meter to be accurate withi commercial requirements.

Commercial aluminium loses greatly b being impure. Very slight traces of impuri spoil the metal. Commercial aluminium con tains traces of silicon, sodium, carbon, and other metals such as iron. A quarter per cen or so of sodium is quite a common impuri and may do great harm. It may not b diffused equally throughout the mass but ma be segregated. This not only makes the met non-homogeneous, and provides veins or flaw of weak metal, but on passing from sodium t aluminium every grade of alloy from near pure aluminium to nearly pure sodium traversed, and some of these alloys are certai to be brittle. Sodium must also have a gre tendency to cause corrosion. Not only doe sodium oxidise in air and decompose wate but the hydrate formed itself, dissolves alumina and attacks aluminium, forming sodium alum inate.

It is questionable if the contamination b sodium can be avoided in the electrolytic pro cesses. There must be sodium present in th electrolyte, and the amount that goes into th metal must be rather a matter of curren density and of the strength of the electrolyt n aluminium. Such impurities as carbon and ilicon give trouble, not only because they alter he character of the metal, but because they re strongly electro-negative to aluminium ; nd when they are exposed in small particles hey form little local couples, and give off ydrogen, thus allowing the neighbouring urface to be oxidised. It would probably make a very great difference in the value of luminium if it could be purified further. Ninety-nine per cent. aluminium is already a ommercial product, but it would be worth much more if it were 99·9 or 99·99 per cent. of aluminium. There is a great opening for a cheap and efficacious method of refining this metal further. There are rumours of such a process recently brought out or set to work in Paris, but no particulars are to hand yet.

One of the great difficulties in the commercial use of aluminium and many of its alloys is that of soldering. The problem of soldering aluminium is like that of making motors for ordinary alternating currents : it is solved with a flourish of trumpets every week or two, but somehow commercial aluminium articles are found to be carefully designed not to need solder. One of the difficulties s to get a clean surface of metal exposed o the solder. The principle underlying the use of such fluxes as zinc chloride, rosin, or borax, is that they dissolve the oxide of the metal to be soldered, and of the solder, leaving wo clean surfaces to run together. Now, here are few chemicals which will dissolve alumina which will not also vigorously attack he surface of aluminium. There are, however, a few substances available, but some of hem need such a high temperature to enable hem to dissolve the alumina that the metal is softened. This prevents such fluxes being used for rolled or stamped aluminium work, as once t is softened the metal loses much of its value. A soldered vessel, for instance, cannot be re-rolled to harden the metal again. One method of getting the solder to stick is to scratch the aluminium under the surface of the solder. There are also several kinds of solder in the market which take on aluminium. This is not enough, however. To make soldering efficient t should not only adhere where carefully rubbed on, but should run easily and quickly into oints and crevices, as in sheet-tin, lead, or brass work.

Once the solder has been got to adhere the oint may be quite useless. It is quite easy, for instance, to solder two pieces of aluminium ogether, so that they will tear through the metal rather than through the solder. Similarly, a screw head may be soldered to sheet aluminium, and when torn off it will take a disc of aluminium with it rather then break the joints. Make these joints and examine them after a few months or even weeks and it will be a very different matter. The solder appears to separate completely from the aluminium, or at any rate it comes off with the slightest force. I believe this does not happen with all samples. It may be due to sodium in the metal, or it may be due to an alloy between the solder and the metal being able to decompose water and thus being corroded. It is possible, for instance, a trace of sodium may help an alloy of aluminium and tin to decompose water. It is a curious thing that a failed soldered joint frequently has the same smell as iron has when acted on by dilute acid. This is generally said to be due to minute traces of hydrocarbon formed from the carbon in the iron, and there is very much less carbon in aluminium. The smell seems to be good evidence of the decomposition of water at the soldered joint. A soldered joint will also sometimes evolve gas very slowly if left in water for some time.

There is another possible explanation which may be brought forward. The two explanations are not antagonistic, and the effects may work together. Aluminium alloys are generally very brittle, or even powdery, if they have a large proportion of aluminium and of the other metal. Thus aluminium with a little copper is a good alloy, and so is copper with a little aluminium, but an alloy of about equal parts is very brittle. Some of the alloys containing large proportions of aluminium and another metal tumble to powder spontaneously in a few weeks. If a metal or alloy is used as a solder, which forms with aluminium in any proportion a brittle or unstable alloy, the probability is the joint will go ; for if you pass from the solder to the aluminium you must pass through strata of solder containing more and more aluminium until you are in pure aluminium ; and therefore you must pass through a stratum of unstable alloy. This stratum must completely separate the solder from the aluminium ; and if it is brittle, or if it spontaneously falls to powder in course of time, the joint must be bad. The obvious cure here is to use a solder that already contains more aluminium than the unstable alloys. Various solders of this sort are in the market.

As regards the uses of aluminium and its alloys enough has been written in the various technical journals. As already suggested, the pure rolled or drawn metal may come into much more extended use when it is supplied free from impurities, such as sodium and silicon. There are other uses than mechanical to which aluminium may be largely applied in the near future. Its great affinity for oxygen, which is its worst characteristic in mechanical work, is its merit in chemical and metallurgical applications. A little aluminium greatly improves many cast metals. It may be that the metals contain dissolved oxide. Copper, for instance, is apt to contain dissolved oxide, which deteriorates it, and is stirred with a green pole before running off. [It was a Cambridge undergraduate who asked his coach if a blue pole would do as well.] It is quite possible that such traces of oxide are reduced at once by aluminium, and that the alumina is insoluble in the molten metal, and rises out at once.

Aluminium can also be used to replace other metals, as it has a very strong affinity for oxygen, sulphur, and chlorine. Thus Vautin makes chromium by heating aluminium with a salt of that metal. Aluminium heated with sulphide of iron yields pure iron with no trace of carbon, a substance that is not familiar to many. As, in such cases, the products are not easily volatile, and as the action disengages a great deal of heat, enormous temperatures may be obtained in this way. In this way almost any metal may be obtained, as few have such avidity for oxygen, chlorine, or sulphur.

The amalgam of aluminium, or amalgamated aluminium, can also be used as a reducing agent in organic chemistry. It decomposes water rapidly, and reduces many organic compounds. It was generally thought that water must be present for the reduction to take place. This is probably the remains of the nascent hydrogen notion of reduction. People saw bubbles of hydrogen come off zinc in dilute acid, and they found reduction of reducible salts took place, so they jumped to the conclusion that the reduction was the result of the nascent gas, not merely another effect of the same cause. Wislicenus and Kaufmann have finally shown that the amalgam works without water; absolute alcohol, previously freed from all traces of water by amalgamated aluminium, being used as the solvent. It is a question of price how far aluminium may come in in the organic colour industry.

There is a difficulty about electro-plating aluminium. It seems as if it might be possible by using a very high-current density, just as sodium can be deposited from caustic. It may also be possible to deposit an aluminium allo from an aqueous solution, as alumina has gre affinity for some metals, incandescing on allo ing, just as sodium does when dropped in mercury. Various accounts of processes plating aluminium from aqueous solutio have appeared, but I, for one, have never see a decent sample of the results. It is, b another process, quite easy to coat iron copper with either aluminium or aluminiu bronze, and to produce a thick and impermeab coating which is quite permanent. This coa ing is rough, however, and has to be filed u and polished; and it is difficult to do th without occasionally getting through the coa ing down to the metal underneath. Such coating may be very useful for large object exposed to rough usage or to the weather, a merely sandpapered up or pickled it has handsome appearance.

The further cheapening of aluminium seem to depend on perfection of detail in manufacture which will be caused by keen competition. Cheaper methods, or, rather, cheapene methods, of producing pure alumina wi gradually be introduced. There has been good deal of talk recently about makin aluminium from the sulphide; but it is difficult to say how far any sulphide process ha been reduced to practice. It might give pure aluminium, and take less power. It migh also save expense in anodes, as at present th anodes are burned just as much as if the were used for reducing alumina in a furnace The use of sodium for replacing aluminiu seems quite a thing of the past. There seem much more chance of aluminium being obtaine by furnaces without electrical aid. The Cowle furnace really seems to work by temperatur alone. The heats of combination do no necessarily settle whether an oxide will b reduced by carbon or not. It may be that th very high temperature is necessarily only t bring the carbon and alumina into contact Either the alumina may melt, or the carbo may volatilise. A solution of alumina in haloid salt is not easily reduced by carbon however.

THE ELECTROLYSIS OF FUSED SALT.

The manufacture of sodium and chlorine, o sodium and bleaching powder, from fused sal direct seems so absurdly simple and easy, tha it is a very tempting problem; and if ther were not very much more serious difficultie than appear at first sight, such a process a the simple electrolysis of melted salt would ery soon oust all others. If a simple method ould be devised, sodium could be made at a ew pounds per ton. It would be used in very arge quantities for the reduction of aluminium, nd for replacing iron in the making of cyanides or gold extraction. It would doubtless also e used in innumerable other processes where cheap and powerful reducing agent could e employed. All this is, however, a small natter; caustic and carbonate would be made rom the metal. Instead of a ton of caustic oda, a paper maker would buy 11½ cwt. of odium, which he would convert into hydrate y treating with water. At present we need ardly trouble ourselves about means of treating sodium with water by the ton. It could, f course, be done. The hydrogen might or night not be utilised, and in some cases it night be worth while to get electrical energy y using the sodium in cells. This is unlikely, owever; and we are not yet sufficiently near he economical manufacture of sodium to discuss its uses at length.

The difficulties in the way of the direct electrolysis of salt are enormous.

In the first place, it must be fused. If it is eated by a furnace it must be in a suitable vessel. Most kinds of stoneware and earthenware are attacked by fused salt, and are also ikely to crack. Iron is the most promising naterial, but in time it will probably oxidise and scale away. The cost of thick cast-iron pots, something like those used in finishing caustic, might not be excessive. It might be possible to heat the salt by the current that electrolyses it. With a given fall of potential spent on the resistance of the electrolyte, it is easier to keep a large vat hot than a small one, so this method can only be used economically on a large scale. The containing vessel may then be practically solidified salt.

The anode does not give any serious trouble. Carbon is practically indestructible in fused chloride of sodium, as even hot chlorine has no action on it. If the salt contains any oxygen compounds, such as oxide of sodium, due to combustion of the sodium or sulphate of sodium, a carbon anode will of course be attacked and eaten away. The chlorine that comes off must be kept within some sort of hood; and this gives rise to a new difficulty. Red-hot chlorine, f one may use such an expression, is not at all convenient to handle on a large scale. Perfectly dry chlorine is said not to attack metals; and sodium will keep a bright surface in contact with dry chlorine. But though the chlorine from red-hot salt must be fairly dry it attacks metals at once. No metal can be used as anode in fused salt, for instance, and after it has come off the chlorine will attack, say, an iron hood. Then there is also difficulty in making good contact between the conducting lead and the anode, as the lead being metal cannot be in contact with the hot chlorine, and the carbon on the other hand must not be exposed to the air. On a large scale it is probable there will also be some difficulty in cooling large quantities of chlorine, as the chlorine must, of course, not be led into the bleach chambers already hot.

The cathode itself of course offers no difficulty. Iron or, perhaps, copper can be used. Sodium, however, floats on fused salt. The surface round the cathode must therefore be covered in, and the sodium either collected and poured off, or distilled over. To distil sodium needs a fairly high temperature, which, other things being equal, is a drawback. A still greater drawback is that the sodium does not distil clean, but comes over mixed with salt vapour, and the sodium and salt are condensed together, making a mixture which is difficult to treat.

The chief difficulty as regards the cathode is the hood. Such materials as porcelain are attacked by sodium or sodium vapour, so sodium must not come in contact with them. If iron or copper is employed, as soon as there is a layer of sodium on the top of the salt it makes contact between the cathode and the hood, and the further liberation of sodium is on the outside of the hood, where the metal burns. This not only means waste, but the oxide formed dissolves in the fused salt, and finally burns the carbon anodes. Porcelain hoods have been tried. Many kinds of stoneware or fireclay will stand fused salt well enough; but it does not follow that it will stand in an electrolytic vat. Apparently at the temperature of fused salt it conducts enough to be practically electrolysed. Poincaré gives the conductivity of hot porcelain as about a hundred-thousandth of that of fused salt. It may also be partly attacked by the rather mysterious subchloride of sodium, which is supposed to be produced. Such a compound may reduce silicates, just as sodium does. Borchers has proposed or used chamotte, which is, I believe, stoneware made of old fired stoneware, ground up and mixed with new slip, and again fired. I do not know what success this material secured. Another proposal is to use porcelain hoods both for the anode and cathode, and to prevent any action by keeping them cool by water circulation. The hood is then coated at all vital points with a casing of cold solid salt, which is an insulator, and protects the porcelain from all attacks on the part of the salt, electrolysis, sodium, or sodium subchloride. Still, the close proximity of melted salt, red-hot sodium, chlorine, and cold water, with nothing but porcelain to separate them, must always be discouraging to a workman whose life is not insured. When all all the difficulties so far mentioned have been successfully surmounted, there is still another drawback, and that is that probably there will be no sodium. If a small current density is used, no sodium will appear. It was most likely this phenomenon that led the earlier experimenters to suppose that fused electrolytes conducted without decomposition, like metals. What really happens it is very difficult to say. It is generally supposed that the sodium forms a subchloride, but a subchloride of a monad element is a little difficult to believe in. Photographers are on very familiar terms with subhaloids of silver, so we must not be too sceptical about subchlorides of sodium. If the cathode is watched in a cell of fused salt, the liquid appears to be violently disturbed, and luminous red streaks come from the cathode. This looks rather as if sodium was being carried in clouds of small particles into the mass of the salt, and these combined with the salt with evolution of heat. If salt is taken from the neighbourhood of the cathode and cooled, and examined through the microscope, it is found to be full of black specks. On adding water there is effervescence. This looks as if the sodium was not in the form of subchloride, but in little metallic globules. The luminous clouds may be merely clouds of globules of hot sodium, the high temperature being due solely to the enormous current density in the immediate neighbourhood of the cathode. The presence of sodium or of particles that may be assumed to be sodium in the cooled salt does not show that they exist at the higher temperature. It is possible that subchloride of sodium exists at the temperature of melted salt, but splits up into normal chloride and sodium on cooling. Lithium if heated in contact with lithium chloride in a closed vessel disappears, apparently forming a subchloride. The subchloride of lithium has even been investigated as regards its fluorescent properties. Chloride of sodium acted upon by cathode rays in a vacuum tube gives off chlorine and turns orange or bluish, and subchloride is said to be formed. Lithium chloride is said to be decomposed in the same way.

It is possible that sodium is not actually deposited against or on the electrode, but in th immediate neighbourhood only. If mercury used as cathode in a strong solution of a lead sa and a large current density is employed it wi be found that lead trees grow on the surface the mercury. Mercury amalgamates clean lea at an enormous rate—so fast that if you agitat the cathode by touching the cell, trees severa inches long will disappear into the mercury s quickly that the eye cannot follow the movement If the surface of the mercury is watched, it wi be seen that the lead is always beginning t form trees, but they are rapidly sucked in b the mercury. It appears as if the lead is no deposited into or really in contact with th mercury, but is thrown down in its immediat neighbourhood, and is then amalgamated b the mercury. If this is the case, it ma account for the small yield of sodium fror fused salt. It is possible the sodium is deposited in very small globules in the immediate neighbourhood of the cathode, and tha a large proportion of it is swept away by th surging salt, and is eventually burnt on th surface of the electrolyte, or turned into sal again at the anode.

The melting point of salt is reduced i practice by adding other chlorides, such a that of calcium, to the bath. Of course onl those chlorides can be used which do no deposit metals more readily than salt. It i quite possible that a little calcium is deposite with the sodium, but it is so difficult to mak sodium commercially by this method that a inventor would feel quite encouraged if h obtained any sodium to speak of, even if i were largely contaminated with calcium.

The difficulty, as regards the collection o sodium, has been overcome by Vautin in a very ingenious way. He uses a cathode o fused lead. According to Borchers, whose works are a veritable mine of information, this idea is old, as Rogers deposited sodium into lead and zinc in 1886-89, and published an account of his successful results. Vautin has gone further than this, however. The lead-sodium alloy is in connection with a second vat to which steam is admitted. This takes out the sodium, and if the steam supply is properly regulated pure fused caustic is produced, and has only to be run into drums and sold. This arrangement overcomes a great many of the difficulties inherent in the electrolysis of fused salt. There is no difficulty in collecting the chlorine, as the sodium does not also rise to the top of the vat.

Lead sodium alloy is available for very many of the purposes for which plain sodium is employed. It would probably not pay to use it for getting aluminium, as the electrolysis and substitution would probably cost more than the simple electrolysis of a cryolite and alumina bath. It is available for the production of cyanides from potassium ferrocyanide. As sodium has a lower combining weight as well as a lower price than potassium, sodium cyanide is, on the whole, preferable to potassium cyanide; and it is, I believe, just as good in gold extraction. It must be practically entirely ionised in the very weak solutions used in leaching gold ores; so the metal can hardly make any difference. As potassium cyanide is estimated by its cyanide, the metal being assumed, the use of sodium in the reaction with the prussiate of potash gives a cyanide which tests at over 100 per cent. This has astonished not a few analysts, but is pretty generally understood now.

Miscellaneous.

*TWENTY-FIVE YEARS MECHANICAL PROGRESS.**

It is remarkable that whilst Great Britain led the van in the introduction of steam locomotion, she has lagged in the rear as regards electric and other mechanical traction. This arose, in the first instance, from mistaken legislation, which strangled electrical enterprise, which is still much hampered by the reluctance of public authorities to permit the introduction of the necessary poles and wires into towns. At the date of the latest published returns there were at work in the United States no less than 12,133 miles of electric, in addition to 599 miles of cable, tramway. Hardly a large village but has its installation, and vast have been the advantages derived from these facilities. In Brooklyn one company alone owns and works 260 miles of overhead trolly lines. With the exception of some small tramways at Portrush, Brighton, Blackpool, South Staffordshire, Hartlepool, &c., the only examples in this country of serious attempts to apply electromotive force to the carriage of passengers are the City and South London Railway and the Liverpool Overhead Railway, the latter being the latest constructed, and having, therefore, benefitted by the experience gained upon the London line. In connection with electric traction, it is very important to reduce, if possible, the initial force required for starting from rest. Whether this will be best attained by the improvement of bearings and their better lubrication, or by the storage, for starting purposes, of a portion at least of the force absorbed by the brakes, remains to be seen; but it is a fruitful field for research and experiment. In the United States there is a very general and rapid displacement of the cable tramways by the overhead wire electric system.

In addition to the application of electricity for illuminating purposes, and for the driving of tramcars and railways, it has also been applied successfully to the driving of machinery, cranes, lifts, tools, pumps, &c., in large factories and works. This has proved of the greatest convenience, abolishing as it does the shafting of factories, and applying to each machine the necessary power by its own separate motor; the economy resulting from this can hardly be over-estimated. It is also successfully employed in the refining of copper, and in the manufacture of phosphorus, aluminium, and other metals, which, before its application, were beyond the reach of commercial application. The extent of its development for chemical purposes in the future no one can foresee. Electric head lights are being adopted for locomotives in the United States. The use of compressed air and compressed gas for tractive purposes is at present in an experimental stage in this country. The latter is claimed to be the cheapest for tramway purposes, the figures given being—Single horse cars, 5¾d.; electric cars, with overhead wires, 4¼d.; gas cars, 3¼d. Combination steam and electric locomotives, gazoline, compressed air, and hot-water motors are all being tried in the United States, but definitive results are not yet published. The first electric locomotive practically applied to hauling heavy trains was put into service on the Baltimore and Ohio Railway in 1895 to conduct the traffic through the Belt Line Tunnel. It is stated that, not only was the guaranteed speed of 30 miles per hour attained, but, with the locomotive running light, it reached double that speed. The actual working expense of this locomotive is stated to be about the same as for an ordinary goods locomotive, viz., 23c. per engine mile.

The rapid extension of tunnel construction for railway purposes, both in towns and elsewhere, is one of the remarkable features of the period under review, and has been greatly assisted by the use of shields, with and without compressed air. This brings into considerable importance the question of mechanical ventilation. Amongst English tunnels ventilation by fan has been applied to those under the Severn and the Mersey. The machinery for the latter is, probably, the most complete and most scientific application up to the present time. The intended extension of electrical underground railways will render it necessary for those still employing steam traction either to ventilate by machinery or to substitute electromotive force. Great improvements have been lately made in the details of mechanical ventilators, especially by the introduction of anti-vibration shutters, and the driving by belts or ropes instead of direct from the engine. The great improvements in subaqueous tunnelling can be clearly recognised from the fact that the Thames Tunnel cost £1,150 per lineal yard, whilst the Blackwall Tunnel, consisting of iron lined with concrete, and of 25 feet internal diameter, has, by means of Greathead's shield and grouting machine, been driven from shaft to shaft, a distance of 754 yards, for £375 per yard. Tunnels have now been successfully constructed through the most difficult strata, such as waterbearing silt, sand, and gravel, and, by the use of grouting under pressure, subsidence can almost entirely be avoided, thus rendering the piercing of the substrata of towns, underneath property without damaging it, a simple operation, and opening up to practical consideration many most important lines of communication hitherto considered out of the question.

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* Extracted from Sir Douglas Fox's presidential address to Section G (Mechanical Science) of the British Association.

A question which is forcing itself upon the somewhat unwilling attention of our great railway companies, in consequence of the continual great increase of the population of our cities, is the pressing necessity for a substantial increase in the size of the terminal stations in the great centres of population. Many of our large terminal stations are not of sufficient capacity to be worked properly, either with regard to the welfare of the staff or to the convenience of the travelling public. Speak to stationmasters and inspectors on duty, when the holiday season is on, and they will tell you of the great physical strain that is produced upon them and their subordinates in endeavouring to cope with the difficulty. This, if nothing else, is a justification for the enterprise of the Manchester, Sheffield, and Lincolnshire Railway Company in providing an entirely new terminus for London. It is thirty years since the last, that of St. Pancras, was added, and during that period the population of London has increased by no less than two millions.

Turning to the subject of Light Railways, if the intended branch lines are to be of the standard gauge, with such gradients and curves as will render them suitable for the ordinary rolling-stock, they will, in many cases, not be constructed at such low mileage costs as to be likely to be remunerative at rates that would attract agricultural traffic. The public roads of this country (very different from the wide and level military roads of Northern Italy and other parts of the Continent) do not usually present facilities for their utilisation. If, in consideration of a reduction in speed, relaxation of existing safeguards are permitted, much may, no doubt, be effected by way of feeders to existing main lines. If, on the other hand, the branches are of narrower gauge, separate equipment will be necessary, and transhipment at junctions will involve both expense and delay. It is very doubtful whether the British farmer would benefit much from short railways of other than standard gauge. He must keep horses for other purposes, and he will probably still prefer to utilise them for carting his produce to the nearest railway station of the main line, or to the market town. It would seem quite probable that motor cars may offer one practical solution of the problem how best to place the farms of the country in commercial touch with the trunk railways, seaports, and marke towns. They could use existing roads, could run t the farmyard or field, and receive or deliver produc at first hand. The passing of the Act of 1896, superseding those of 1861 and 1865, will undoubtedly mar the commencement of a new era in mechanical roa traction. The cars, at present constructed chiefly b German and French engineers, are certainly of crud design and leave much to be desired. They are ugl in appearance, noisy, difficult to steer, and vibrat very much with the revolutions of their engines, risin as they do to 400 per minute; those driven by oi give out offensive odours, and cannot be readil started, so that the engine runs on during short stops There would seem to be arising here an even mor important opening for the skill of our mechanica engineers than in the case of bicycles, in whic wonderful industry the early steps also appear to hav been foreign. It is claimed for a motor car that i costs no more than carriage, horse, and harness; tha the repairs are about the same; and that, whilst horse, travelling about 20 miles per day, represent for fodder a cost of 2d. per mile, a motor car of 2½ horse power will run the same distance at ½d. pe mile. The highway authorities should certainly welcome the newcomer, for it is estimated that two-thirds of the present wear and tear of roads is caused by horses, and one-third only by wheels.

THE WOOLLEN INDUSTRY OF GERMANY.

The principal persons engaged in the woollen industry in Germany, conscious of the excellence of the products of their chief competitors, especially the French and English, have made every effort not only to regain the home market but to meet their opponents in parts of the world hitherto held by England and France. The difficulty of meeting all the requirements of the times in the matter of fashion, form, quantity, and quality has, says the United States Consul at Chemnitz, been overcome. Germany is now rapidly putting herself in a position to supply all the demands of her cloth manufacturers, and although she is obliged to buy large quantities of woollen yarns from England she appears to be resolved to be independent. Her woollen goods have gained a great deal in quality and colour. The earnest efforts of the manufacturers have been aided by Government assistance and encouragement in the shape of technical schools, exhibitions, &c. Aix-la-Chapelle, Gera, Greiz, and Crimmitzschau in Saxony, are sending tons of goods worth millions of marks to the United States, Australia, Africa, South America, India, and China. The number of spindles in the woollen industry in Germany rose from 1,669,759 in 1861 to 2,787,373 in 1875, and to 3,600,000 in the present year. Of these 1,600,000 spin worsted and 2,000,000 carded yarn. The amount of raw wool spun in 1860 was 41,430 tons; in 1895, 198,479 tons. The imports of raw wool were 18,300 tons in 1860, gainst 183,202 tons in 1895. The reports of raw wool were 4,770 tons in 1860, 20,100 tons in 1875, ,014 tons in 1890, and 11,223 tons in 1895. The production of raw wool went up to its highest point —38,580 tons—in 1865, and it gradually sank to 2,500 tons in 1895. The imports of shoddy wool were 5,325 tons in 1880, 12,240 tons in 1890, and 2,845 tons in 1895. The exports were 14,168 tons in 1880, 14,663 tons in 1890, and 15,341 tons in 1895. In the forties Germany led the nations of Europe both in the quantity and quality of wool produced. Her exports largely exceeded her imports, and the breeding of wool-producing sheep was one of the most important as it was one of the most profitable branches of farming. This is now entirely changed, first because of the increased value of land for other and better paying products, and, secondly, because of the enormous production in foreign countries, viz., in Cape Colony, lands along the La Plata River, and in Australia. Hence the wool produced in Germany covers only one-sixth of the present demands, nor does even that pay for the efforts put forth in competition against the products of the countries above-mentioned. Nor, it is said, is there much to be made out of the new move to encourage the use of home products, manifested more particularly in an effort to compel merchants manufacturing supplies for the military and marine to use German products exclusively. About 1860 Germany had 28,000,000 sheep, in 1873 she had 25,000,000, in 1883 19,000,000, and in December, 1892, 13,500,000. In 1860 there were 52 sheep to each square kilometre of territory, in 1892 only 25. In 1860, to every 100 inhabitants, 73 sheep; in 1892, 27. The claim is made that moderate protective tariffs have helped the German woollen manufacturers to hold not only their own, but to obtain a fair share of the markets in countries not yet advanced enough to manufacture for themselves. In 1895 the country used three times as much raw wool as in 1865; had won back all the home markets held hitherto almost entirely by England and France, and had gone into all parts of the world with the surplus products of her woollen looms, winning new fields from her powerful rivals. The exports of woollen yarns went up from an average of 101,000 centners during the sixteen years, from 1872 to 1887, to 181,000 centners in 1895. During the same period the export of woollen cloths and tissues went up from 390,000 centners to 616,000 centners, while the imports of woollen wares and cloths went down from 86,000 centners to 31,600 centners. Consul Monaghan says that all this success had its origin in the simplest of causes. The German has no hesitation in getting aid where and when he can. He has his agents in England, France, Belgium, and the United States. He collects patterns and designs, and experiments until he obtains an article equal to the original, or so nearly equal as to replace it by means of considerably reduced prices. He has many economies in his factory unknown to the English or the American manufacturer, or if known, never practised.

ARTIFICIAL SILK IN FRANCE.

Artificial silk, says Consul du Bellet, is soon to be manufactured in Rheims and Fismes, the latter a neighbouring town, situated 19 miles west of the north-eastern part of France. The erection of buildings for this new industry has actually been commenced. This silk is called "Chardonnet" silk, after the name of its inventor, and although the process of manufacture is not yet fully known, it is asserted that the *modus operandi* is somewhat similar to that of the silkworm itself. The silkworm eats mulberry leaves, and after a mysterious transformation which takes place inside the insect, it emits through the mouth an extremely fine thread, which it uses to spin its cocoon; this thread is silk. The process for the manufacture of artificial silk is based upon that employed by nature. The first thing used is wood, for mulberry leaves are in reality the equivalent of mulberry wood. The wood is worked into a paste, which, after being dipped in nitric and sulphuric acids, is dried, and placed in a bath of ether and alcohol at 90°. A transformation takes place, and a kind of glue or collodion is the result. Such is all the preliminary work necessary, and such is the material with which the artificial silk is to be produced. The collodion is placed in strong metallic cylinders, where it is subjected to high pressure, and runs in pipes of the size of ordinary gas pipes. These pipes are laid horizontally, and small faucets are fastened at regular intervals over their whole length. A woman opens a faucet, and from a glass tube an extremely fine thread is seen emerging; it is the collodion driven by the pressure. The small glass tube replaces in the manufacture the mouth of the silkworm. The thread, as it comes out of the glass tube, is so fine that is necessary to twist six of them together before winding on the spool. The silk so made is then rendered incombustible, and the skeins are thrown into ammonia, for the purpose of neutralising the sulphuric acid. Two grand prizes were awarded to M. Chardonnet for his exhibits of artificial silk at the Lyons Exhibition of 1894. In conclusion, Consul du Bellet says that the people of Rheims and its district are watching with marked interest the development of the new enterprise, which, in case of success, will furnish steady and regular work to the weavers of Rheims.

PETROLEUM PRODUCTION IN THE UNITED STATES.

According to a recent American report, the most notable features in connection with the production of crude petroleum in the United States are—(1) The great increase in production, especially in Ohio, Indiana, and California; (2) the decrease in stocks; (3) the rise in prices; (4) the extension southward of the profitable producing districts in the Appalachian range. Briefly summarised, the facts are as follows:—

The production in the United States increased from 49,344,516 barrels, in 1894, to 52,983,526 barrels in 1895, most of the important producing districts sharing in this increase. The production of Pennsylvania increased from 18,077,559 barrels to 18,231,442 barrels; of Ohio, from 16,792,154 barrels to 19,545,233 barrels. This increase in Ohio was fairly distributed throughout the two important producing districts. The production of Indiana increased from 3,688,666 barrels to 4,386,132 barrels, while the production of California, owing to the new discoveries at Los Angeles, increased from 705,969 barrels to 1,208,482 barrels. On the other hand, there was a slight decrease in the production of West Virginia and New York. The stocks of crude petroleum in the Appalachian oil-fields at the close of 1895 were 5,344,784 barrels, as compared with 6,499,880 barrels at the close of 1894. The petroleum producing localities in the United States remain about as they were in 1894, the only important addition o the producing territory being the Los Angeles district in Southern California; but this is hardly to be regarded as new territory, as it is surrounded by the older producing districts of that State. Most of the oil produced in the United States in 1895 is still from the Appalachian district; all of that produced in New York, Pennsylvania, and West Virginia, together with that produced in Macksburg, the eastern and southern Ohio, and Mecca-Belden districts of Ohio, being from this great field. In this district there were produced, in 1895, 30,959,139 barrels out of a total of 52,983,526 barrels, or nearly 58½ per cent.

PEPPERMINT-OIL INDUSTRY IN JAPAN.

"Kuhlow's German Trade Review" says that Mr. G. Marx has communicated to the German Society in Tokio (a society which undertakes the study of the natural history, and of the inhabitants of the East) a paper dealing with the distillation of peppermint-oil in Japan. From this it appears that the industry has not yet benefited by the introduction of European methods, although it is one of considerable importance. It is the opinion of many that the substitution of an improved method for that now followed would benefit both the quantity and quality of the oil produced. The apparatus universally adopted in Japan consists of cast iron broad-edged boilers, wooden vats, and a condenser. Generally there are three sets of stills, &c., combined in one battery, with a common furnace. They are arranged in steps so that the lowest is built into the ground. The process is begun by filling the boilers with water, then the vats, which have perforated bottoms, are placed on the broad edges and surrounded with straw bands and soft clay. It is in these vats that peppermint is placed. Next the inverted condenser is put on and filled with water; the heat passes from below and disappears through the chimney, on which the distilling begins. The boilers are properly heated by the fumes as they pass, and sufficiently so, as one is smaller than the others. The steam penetrating the herbs, carries with it the essential oil, and condenses on the outer side of the condenser, being collected in the vessel hanging upon it, from which the condensed water containing the oil passes through a bamboo reed inserted in a flask. Each of these consists of a little wooden container, in which a glass cylinder (an old bottle without bottom or neck) is inserted. In this, the water separated from the oil runs through a little pipe again into the boilers. As soon as the water in the condenser becomes hot, the workman replaces it with cold water. The emptying is effected by a bamboo syphon. The workman inserts the short arm in the inverted cooler, closes the lower opening, and sucks the syphon until the water flows into it.

MANUFACTURE OF WINE FROM RAISINS IN RUSSIA.

Although in most countries strict laws exist for the regulation, preparation, and inspection of food and drinks—in the first place, from the standpoint of health, and, in the second place, for the purpose of collecting revenue—some articles are openly manufactured that cannot be accurately watched and assessed, and these are sold for something else than they actually are. For example, the United States Consul-General at St. Petersburg says that complaints have recently been made by the directors of the excise departments in different governments in Russia that a wine is made of raisins and sold for Hungarian wine and Russian fruit Kvas, which competes with the Russian grape wine. In governments densely populated by Hebrews, as in the kingdom of Poland, in the north-western and south-western regions, the production of wine from raisins, which is used by the Hebrews for some of their religious ceremonies, has greatly increased, its total production in Russia being now more than 337,000 gallons a year. The average wholesale price is about 2s. 6d., and the retail price about 3s. per gallon; but in some of the outside governments this wine sells at very high prices, especially in the government of Chernigov, where it retails at 19s., and in the government of Vilna at 15s. per gallon. In 32 governments, and in the Ter and Ruban regions, and in western Siberia, raisin wine is not made at all. The preparation of the wine is very simple. The raisins are finely chopped, put into a vat, and warm water poured on them. The strength and quality of the wine depends upon the quantity of the water used. Generally, for one poud (36 pounds) of raisins, from 5 to 13 gallons of water are used, from which 3½ to 5½ gallons of wine are obtained. The raisins are left from four to five days to ferment, and then the liquid is poured through a filter, and the wine is ready. Sometimes this wine, which is naturally of a yellowish colour, is coloured with burnt sugar or with black currants. It is very strong, containing about 12 per cent. of alcohol. On account of the simplicity of its preparation, no control is possible, and consequently it gives every opportunity for evasion and abuse. Wine is also made from berries and fresh and dry fruit; but the quantity is insignificant, because it is difficult to sell, on account of its high price. According to official returns, the total yearly production of wine in Russia is estimated to exceed 26,000,000 roubles in value. The Ministry of Finance, being desirous of protecting the public and the excise against fraud from raisin wine, has just issued the following regulations concerning it:—The factories where wine from raisins is made shall pay, according to the location, a tax as high as the wine sellers have to pay. The strength of the wine shall not exceed 12 degrees of alcohol. The wine is to be put upon the market in glass bottles only, which must bear labels of certain colour, prescribed by the Ministry of Finance, with the inscription "raisin wine" on them. It is strictly forbidden to print on such labels the name of any other wine. Violation of these regulations will be punished by heavy fines.

PRODUCTION OF SALT IN SPAIN.

The City of Cadiz rises apparently from the very midst of the sea, the waters of the Atlantic washing its walls on all sides except one—that by which communication is maintained with the mainland some leagues away by a long curving strip of sand so narrow in places that the waters from either side almost wash over it at high tide. The city occupies the whole surface of the extremity of this sand spit, which is in appearance, and almost in reality, an island. The railway leading from Cadiz to Seville and Madrid follows the narrow ribbon-like isthmus above-mentioned, which gradually widens as the mainland is approached into a broad marshy plain of considerable extent and but a foot or two above the tide in its highest parts. The United States Consul at Cadiz says that the surface of this plain is intersected in all directions by small canals and shallow basins, arranged on more or less systematic series, and the traveller by rail will observe groups of white pyramids, from fifteen to twenty feet in height, rising here and there from the midst of this low-lying marshy wilderness. A closer inspection will show that these groups of pyramids, which altogether number some hundreds, and which at first sight appear to be scattered promiscuously over the broad "marisma," are in fact placed on the "made ground," resulting from the excavation of the different series of basins already referred to, and in close proximity to the latter. These white pyramids are veritable pillars of salt, and the basins and canals are part of one of the most extensive and important industries of Cadiz—the production of salt by solar evaporation—an industry that is probably much older than the modern Cadiz itself, as there is every reason to believe that the Roman conquerors of the Iberian Peninsula produced salt on the same ground and by precisely the same process. There is authentic historical mention of the business in the fifteenth century and perhaps earlier, but its development to its present proportions is of comparatively recent date. The method of operating the "Salinas," as the works are called, is very simple. A saline river of considerable width and of sufficient depth to float lighters of small tonnage, crosses the plain from the Bay of Cadiz on one side to the Atlantic on the other, and acts as a feeder to the network of canals from which the sea water at high tide is let into the basins of the "Salinas" whenever a fresh supply is wanted. The sluice gates of the basin are then closed, and the bright hot sun of Andalusia soon evaporates the water, leaving a deposit of salt at the bottom. Water is again let in and the process is repeated until the deposit of salt in the basin reaches a depth of several inches, when it is shovelled up with wooden shovels, thrown into barrows or baskets carried on the backs of asses, and wheeled or carried up to the "montones" or pyramids, where it is deposited to await shipment. The surfaces of the pyramids, which are quite symmetrical in shape, become indurated from the action of the weather, and the salt can be preserved almost idefinitely in this way, though at the expense of a small per-centage of loss each year from the winter rains. The cost of production is very low and the profits of the owners of the works corresponding large. The total amount of capital invested in the business is about £400,000, distributed among 100 "socios" or shareholders. These shareholders do not constitute a single corporation but a number of independent concerns. The several firms and companies however have organised themselves into an association known as the "Concierto Salinero," which not only fixes the price of the salt when placed alongside the ship and the rates of wages, but also fixes the "turns" in which the various firms shall ship, regulating the shipments by rotation, so that all may enjoy equal advantages in the trade. The associated concerns form a monopoly, and their earnings are not made public, but reliable estimates place their average annual profits at from 12 to 15 per cent. During the working season, which extends from May to October inclusive, the operations afford employment to about 1,500 men, the hours of labour being from sunrise to sunset, but with intermissions that reduce the working time to eight or nine hours. The aggregate annual production of the Cadiz "salinas" is about 315,000 tons. The transportation to the ship is effected by means of lighters upon which, owing to the easy access afforded by the canals, the salt is loaded directly from the "montones." The bulk of the product is exported, most of it going to the Argentine Republic and other South American countries, where it commands a good market, its quality and cheapness specially adapting it to the general requirements of those places. No attempt is made to refine the salt, which is of a coarse quality and with a slight admixture of earth or silt, resulting from the crude process of production. The production of salt by solar and artificial evaporation and by mining is one of the most important and valuable industries of Spain, the business being carried on in a number of places to a greater or less extent. In the "Zona Maritima," in which the system of solar evaporation is pursued, there may be mentioned among other places besides Cadiz as centres of production, Torrevieja, San Pedro de Pinaton, and Cabo de Gata. The principal mines ("Manantiales Salitrosos") are those of Cardona in Cataluña, Minglanilla in La Mancha, Imon, and others. The total annual production of the country amounts to a very considerable quantity, affording employment and sustenance to thousands of persons and yielding large returns to the operators.

Obituary.

The Right Hon. George Denman.—The Right Hon. George Denman, whose death on the 21st is announced, was a member of the Society from 1865. He was the fourth son of the first Lord Denman, and was born in 1819. His career as a young man was a rare combination of scholarship and athletic distinction, for he was senior classic at Cambridge in the same year as the one in which he rowed in the winning University crew. He was called to the Bar in 1846. In 1859 he entered Parliament as member for Tiverton, which borough he represented, with some intermissions, until his appointment to the Bench in 1872. For a full account of his distinguished career, both in Parliament and on the Bench, reference may be made to the columns of the daily papers. He retired in 1892.

General Notes.

Queensland International Exhibition.—The *Times* announces that it has been decided to hold an international exhibition in Brisbane in 1897. The Government of Queensland have granted their official patronage to the undertaking, and Sir Arthur Hunter Palmer has accepted the office of president. The proposal has been warmly taken up by the people of Queensland and the adjacent colonies, and the necessary capital has already been subscribed. The Exhibition will be opened on May 5, 1897, and will continue open for about three months. The site chosen for it is in Bowen-park, and covers about 11 acres. Its objects are thus described in the pr spectus received from Mr. Porel D'Agrond, of 9 Leadenhall-street, E.C., the acting commissioner London:—"To promote and foster industry, scienc and art, by inciting the inventive genius of our peop to a further improvement in arts and manufacture as well as to stimulate commercial enterprise, inviting all nations to exhibit their products, both the raw and the finished state. Samples of the pr ducts for which this and the other Australian coloni have become famous will be exhibited, with a view increase the development of their natural resources. Similar exhibits are expected from Great Britai Europe, America, India, Canada, Japan, China, th Cape, and the other colonies, to which the Gover ment of Queensland have forwarded an official invit tion to grant their substantial support to the unde taking. A fine art section will form a department the Exhibition, and for the accommodation of the a treasures and the historical objects a special block the building will be reserved. There will also be woman's industrial and an artisan section.

Sewing Machines in Turkey.—Sewing ma chines are found in Turkey not only in the seaport and the districts served by the railways, but also i Erzeroum, Diarbakir, Damascus, &c. Their intro duction is principally due, according to *Handel Museum*, to a German-American house, which ha established about 150 agents in Turkey. At th present day Turkish, Greek, and Armenian wome appear to appreciate very highly the usefulness of th sewing machine and its advantages over manua labour. Of the 18,000 to 20,000 machines importe annually into the Ottoman Empire the greater par are for the use of families and consist of hand machines, while the remainder is composed of treadl machines for use in the various industrial establishments. These machines come not only from Germany, but also from England, the United States, an Austria.

The Swiss Silk Trade.—The value of the exports of silk piece goods from Switzerland, including neckwrappers and shawls, in 1895 amounted t 86,750,000 francs, as compared with 77,500,00 francs in 1894, an increase of 9,250,000 francs. The exports to France increased from 8,000,000 to nearl 10,000,000 of francs, but it is believed that this export will not reach more than the half of what it wa before the establishment of the French Custom Tarif of 1892. A duty of 200 francs per 100 kilogrammes on black silk goods is regarded as absolutely prohibitive. The United Kingdom is always the largest purchaser of Swiss silks—33,200,000 francs against 29,840,000 francs in 1894. The United States bought to the value of 20,250,000 francs against 17,153,000 in 1894, and Germany to the value of 8,646,000 as compared with 6,563,000. A falling off is shown in the case of Austria-Hungary, Belgium, and Turkey, and some other less important countries.

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CANTOR LECTURES.

APPLIED ELECTRO-CHEMISTRY.

By James Swinburne.

Lecture IV.—Delivered May 18, 1896.

Electrolytic Caustic and Bleach.

Inventors are still devoting their attention to curious vats and queer diaphragms. In some ways it seems as if too much attention has been given to electrolytic alkali. The alkali business is so enormous that it is a great temptation to inventors, but on the other hand the products are low priced, and therefore there is not so much margin. It does not seem to be quite well enough understood that electrolytic alkali is not waiting for some wonderful vat. The processes already in use are quite good enough to give enormous profits if worked economically, but careful supervision is necessary, and great attention to detail. Unfortunately such processes generally get into the hands of limited companies, and limited company management is seldom conducive to success in such cases. It must also be borne in mind that the cost of the electrolysis itself is a small portion of the cost of making electrolytic caustic and bleaching powder. So small a portion of the cost is it, that a great improvement in the vats would make very little difference in the price of the finished material. Unfortunately every one wants to have a vat or system of his own invention. A manufacturer who started up with the determination to use no apparatus which was patented or called after anybody would have a much better chance of success, especially if he employed a few sharp young chemists to watch the vats, make tests, and find out the very best conditions for working. Generally the various inventions consist of varieties of porous diaphragm. Of course an arrangement like that of using mercury as an anode and cathode in one is a different matter. This gives pure caustic, as there is no chlorine in the cathode chamber. If no hydrogen is given off at the surface of the mercury in the anode compartment the current efficiency must be unity. Having no salt in the caustic means considerable economy in finishing.

Some injustice has been done to this process by those who have raised the cry that the mercury is poisonous. There can be no danger whatever in such a case. I have had charge of lamp works where mercury is used in the exhausting rooms, where it seems to be ubiquitous. Yet all that is needed is to keep the mercury clean, so that it does not flour or powder. When a glass pump breaks, the mercury gets all over the linoleum covered floor, and is merely swept up. In spite of this, I have, in several years, never had the slightest case of salivation. When the mercury is permanently under liquid, as in the alkali process, it is quite absurd to suggest danger to the health of the workmen.

One of the difficulties in making bleach is that the anodes are attacked, and a proportion of carbon dioxide is given off with the chlorine. This converts some of the lime into chalk, and lowers the possible per-centage of available chlorine. I have found—at least on a small scale—that this difficulty can be overcome by letting the chlorine and carbon dioxide first pass over some bleaching powder, which takes up the dioxide, giving off chlorine instead. When it is converted into chalk it is thrown away. It would be useless to burn it into lime, as it contains chloride as well as carbonate. By this means good bleach can be made. It seemed possible that the carbon dioxide would evolve hypochlorous anhydride, which would be taken up by the lime, giving bleaching powder with a higher per-centage of available chlorine than usual. It is doubtful if such a reaction takes place, and still more doubtful if it could be worked on a large scale. Mr. Charles Waite was, however, before me in working out this scheme, and it has been in operation at the Rumford Falls Electrochemical Works for some time now.

Recently, Dr. Hurter has urged that it is impossible to get strong caustic in an ordinary vat at a high current efficiency. I do not understand Dr. Hurter's reasoning, and so I may quite unintentionally misrepresent his views. At a discussion on Mr. Hargreaves' paper, at the Society of Chemical Industry, where I first heard Dr. Hurter's views, I suggested that he was confusing the carriage of the charges by the ions with the liberation of the final products at the electrodes. I have not seen the printed account of this meeting yet, so do not follow Dr. Hurter, but he kindly sent me a paper, read by him at the Liverpool Physical Society in 1893. Unfortunately I cannot follow this either, but as far as I can make out Dr. Hurter thinks that in a solution containing salt and caustic the current is carried partly by the hydroxyl ions and partly by the sodium and chlorine ions, with which I agree; and that the portion carried by the hydroxyl, or by the hydroxyl and some of the sodium ions is useless because it does not make more caustic, with which I disagree entirely. As long as there is available chloride in the immediate neighbourhood of the anode, chlorine and not oxygen will be evolved. At the cathode again hydrogen must be evolved. This being the case either caustic and chlorine are made, or caustic gets at the anode and takes up the chlorine making hypochlorite and perhaps chlorate.

Again, if hypochlorites or chlorate get to the cathode they will be reduced wastefully. But these are conditions that would not occur in a rationally conducted works. If you put salt into a vat and stir it round during the electrolysis the result will obviously be that very soon hypochlorite will be formed in large proportions at the anode to be reduced again at the cathode. But then nobody tries to make soda and chlorine that way. Suppose, however, that the liquid is still, and there is a porous partition. Start with all chloride. Chlorine comes off at the anode, and hydrogen at the cathode, and caustic appears at the cathode. We now have, in the anode compartment, chlorine moving towards the anode and sodium towards the cathode. In the immediate neighbourhood of the cathode we have both caustic and chloride. We thus have the current there borne by the sodium moving towards the cathode, and also by hydroxyl ions moving towards the anode, and chlorine ions moving towards the anode. Eventually the hydroxyl ions will reach the porous partition, and they will finally go on into the anode chamber, and we shall there have caustic which will take up chlorine and make hypochlorite. This, I take it, is Dr. Hurter's difficulty. If the current were borne entirely by the sodium and chlorine, all the chlorine would eventually move into the anode chamber, and all the sodium would move into the cathode compartment. In practice, however, we have to run brine into the vats continuously, and run off caustic solution. The ionisation of the caustic and salt depend on the strength of the solution with regard to both. I need not take actua figures, as it will serve my purpose to suppose for the moment that all the current is borne by the hydroxyl, the chlorine and both lots o sodium ions being idle and not migrating a all. Of course in the anode chamber, where I assume no caustic for the moment, the current must be borne by the chlorine. Then we have a sort of army of hydroxyl ions marching from the cathode towards the anode at a certain rate We admit the brine to the anode compartment, and we draw off caustic liquor from the cathode chamber. Then all we have to do is to feed the brine at such a rate that the whole of the liquid moves at the migration velocity of the hydroxyl. The hydroxyl then really stands still, and never gets to the anode. What is drawn off is really a mixture of salt and caustic. The vat has full efficiency, as hydrogen comes off at the cathode and chlorine at the anode. The current being borne by the hydroxyl makes no difference in the current efficiency of the vat, as the current borne by the hydroxyl is just as effective as that borne by the sodium or chlorine ions. The real difference is in the amount of salt it is necessary to draw off with the caustic. If the current were all borne by the chlorine, we could get pure caustic solution off. The relative ionisation of the salt and caustic affect the proportion of salt and caustic drawn off, and thus influence the cost of finishing; but they do not affect the current efficiency. I hope I have not misrepresented Dr. Hurter in any way.

In the case of making chlorate, all that is necessary is to feed the potassium chloride in at the cathode end, and draw off the chlorate at the anode. The same vat gives either product, according to the direction of the fluid current. Of course the chlorate vat must be hot, and as the anode liquid is not acid, platinum anodes are available. I tried small chlorate vats on this principle some years ago, but have made very few and imperfect experiments on caustic soda.

COPPER REFINING.

There is but little to be said about copper refining or the electrolylic extraction of the metal from its ores. A great deal has been published about refining, and still more about various schemes for extraction, and there would be little use in repeating such accounts here. At the same time, there is a great deal

—as Badt points out—that is not published. Copper refiners seem to think they are working a magic secret process, and that if they keep all the details to themselves no others will be able to compete with them. Such ideas are commonly to be found among workmen, but are seldom encountered among educated people; and the probability is that the various copper refiners are working their processes as badly as they can be worked, and understand very little about electrolytic work. The unfathomable secret guarded by copper refiners seems to be the use of anodes and cathodes of copper in a solution of copper sulphate. As regards details of management or of processes, such as the best temperature to work at, or the best method of circulating the liquid, there can be very little to learn. It would be much better, however, for electrolytic copper refiners to publish results and compare notes, as if they are competing with one another, any knowledge, shared equally among them, makes no difference, but it puts them all in a better position as competitors in the race with refiners who use ordinary metallurgical methods. The same sort of thing went on in early days among incandescent lamp makers, and, in fact, it still goes on. Fortunately, workmen are migratory, and wandered from factory to factory, so that each factory knew what the others were doing, but thought its own processes were profound and valuable secrets. The more insignificant the works, and the more idiotic the process, the greater was the secrecy observed.

The main difference between two classes of copper refining processes consists in the series or parallel coupling of the plates. From a purely electrical point of view, this looks like a distinction without a difference, but there is more in it than appears at first sight. It makes little difference in the energy used per ton of copper refined, the only source of divergence being the numerous contacts in the parallel system. When a vat only takes a fraction of a volt, a large proportion of the power may be wasted on imperfect contacts.

The series arrangement, however, saves a good deal of money in the leads, and greatly simplifies the connections. It is often supposed to have some magic efficacy in giving a greater output of copper for a given power, but that is absurd. Its great advantage really lies in its needing less copper in the vats for a given output. This may seem a small matter, but if prices are worked out it may mean a very important saving. Take an example. Suppose copper is deposited at say five amperes per square foot; and suppose the anodes are cast say three-quarters of an inch thick, and are eaten off both sides. Roughly the anodes will take two months to be deposited on the cathodes. Take the case of a refinery dealing with 1,000 tons of copper per month. This means that 2,000 tons are in the vats. As a matter of fact there will be a little more, but we can take 2,000 tons as a good round figure. The value of this copper at £60 per ton is £120,000. Now the question is what value is capital to the owners of the refinery. They might perhaps be able to borrow money, partly on the security of the copper at a low interest; but it is more likely that money is worth 6 per cent. to them, or in other words that their works give 6 per cent. on the capital sunk, and would give at least that interest on any further money sunk safely in enlargement. The interest on the copper in the vats is thus £7,200 a year or £600 a month. As the output is 1,000 tons a month this means that the price of refining copper is increased no less than 12s. a ton for interest on the metal in the vats. It is then of great importance to keep down the amount of copper going through the works, that is to say to make it go through quicker. A little can be done by removing the cathodes when they are three-eighths of an inch thick instead of three-quarters, and putting new ones. This reduces the 12s., not to 6s., but to something above 9s., how much above 9s. depends on the cost of the initial cathodes. Many people may say there are such quantities of copper all about a copper refinery that it makes no real difference whether it is in the vats or in the stores. This argument is fallacious, for the copper in the vats is not available to fill orders, like the finished copper in the stores. The stock of crude copper is merely a kind of buffer or regulator to take up the variations in supply, and give a constant feed to the refinery: the stock of finished copper is to enable a slow and steady production to cope with sudden and irregular demands. The copper in the vats cannot act in either way, and is quite independent of the stocks held, and it cannot be drawn upon. It therefore represents capital lying idle. It is still an open question whether the series arrangement, as series arrangement, saves money. At the Bridgeport works in Connecticut, which are I think the largest electrolytic copper refining concern in the United States, the system worked out by Hayden is used. The anodes are rolled and are quite thin. I forget the dimensions just now, but think they were about an eighth of an inch when I saw them. They were arranged in wooden vats taking something like 120 volts, connection being made to one at one end, and to a special cathode at the other. Each of the intermediate plates then becomes both cathode and anode, as one side of it is eaten away, while the other has copper deposited on it. As the plates are rolled they are eaten and deposited very evenly, and the process is carried on till very nearly the whole of the copper is transferred. As the deposited copper never sticks tight to the plates, the remains of the original anodes can be picked off the refined copper. There is, of course, a certain amount of scrap anode which has to be remelted and rolled again, but as no leads have to be connected to the anodes, and as they are finally supported by the deposited copper, they can be consumed much more completely than in the case of thick cast anodes. The saving is thus essentially in the use of thinner plates, and in the cost of doing away with the necessity for making electrical connection to each plate with its attendant loss of power, due to inferior contacts. The saving in leads about the vat house is also considerable. The most important of these points is, undoubtedly, the thinness of the plates in the vats. There seems no reason, however, why equally thin plates should not be used in the parallel system. There is no reason why the parallel system should be tied down to cast anodes, which must be fairly thick to allow of casting. It might be possible to cast the anodes thinner by adding a little extra silver. I have heard that a very little silver allows copper to be cast well, but do not know if that is correct. The silver would practically all come out again in the refining. Whether a trace of aluminium would do is another matter. It would, of course, be lost, and would gradually accumulate in the bath. These are merely crude suggestions. The series arrangement has been worked out, no doubt independently, by Smith, Hayden, and Stalmann. Who invented it, I do not know. It is described in a pamphlet by Hugon, dated 1885, but I do not know that any copy came into England or America until several years later. Hugon discusses the question of economy of capital sunk in copper going through the process; in fact, it is his main point, and he makes out that the series arrangement is cheaper, but it is difficult to see why, unless the series arrangement alone allows thin anodes and cathodes to be used. Hugon also discusses the use of cuprous chloride. Cuprous chloride gives twice as much copper as cupric sulphate with a giv current; but that is not everything, and unle the resistance of the vat is so low that twice t pressure is not necessary, this does not pa It might be said that a specially low curre density might be used, but that means sur capital again. I do not know at all how f the chloride would do, as it might carry ov impurities that remain in the slimes in a su phate solution. Copper nitrate gives goo deposits of copper with enormous curre densities, but it is probable that silver and, pe haps, gold are carried over. Swan has mad numerous experiments on rapid depositio from the nitrate, but has, I think, publishe nothing as to its use in refining argentiferou copper. The presence of a very little chlorid might prevent silver coming over, but it woul hardly stop gold.

Stalmann, who was for some time manage and who designed the Anaconda electrolyti copper refining works, uses a very ingeniou series arrangement. Each plate has pape stuck to one side. A few copper rivets ar put through, and the paper is blackleaded This gives a paper cathode, which separate the deposited copper from the crude, an gives no trouble in separating the scra anodes from the good deposited cathodes.

It is often supposed that everything electrolytic is pure. Unfortunately, this is no necessarily the case. Electrolytic copper i nearly pure, but it is generally, if not always contaminated with antimony. It is probabl this small trace of antimony does harm, as i most likely reduces the conductivity appreciably, and may alter the non-electrical physica properties of the metal. Antimony can b separated from copper by electrolytic analysis What is wanted is a method which is possibl on a commercial scale.

By the way, there is no space here for a discussion of electrochemical analysis, but ther is just room for an urgent appeal to analysts not to measure electrical quantity in terms o bang-gas. Until quite lately, electroplater and writers on electrolysis used the Smee cel as the unit of everything. When they tol you they had passed the current of 57 Smee cells through anything they thought they had given you information. The Smee cell, as a fundamental unit of everything, still lives in the somewhat muddled minds of many writers on electrolysis and electroplating of the old school. But in electrochemical analysis—which is a new branch of science—surely we might expect chemists to work with volt and ampere meters, and to use the methods of other scientific men.

CALCIUM CARBIDE.

This compound has created an enormous sensation in the financial world, or at least in the speculative part of it, during the last year or so. As far as its discovery in America goes it appears to have been a mere matter of chance, an invention in the literal meaning of the word. The formation of calcium carbide from carbon and lime seems to be a mere question of temperature, and to have nothing to do with electrolysis. It may be that lime and carbon do not react until the lime is fused or the carbon volatilised, and that the temperature of the electric furnace is needed to bring this result about. It is probable, however, that the very high temperature is necessary to bring about the reaction, apart altogether from getting the lime and carbon into contact. I have tried some experiments with an oxygen furnace, and have not succeeded in making calcium carbide even when I used a solvent for the lime, so that there was no doubt that it came into contact with the carbon. These experiments were not tried thoroughly enough to be conclusive, but they tend to show that an exceedingly high temperature is needed. It is hardly necessary to say that an oxygen furnace, that is to say an injector furnace fed with an oxygen and coal-gas blowpipe, gives a pretty high temperature.

The future of calcium carbide depends very largely on its cost of manufacture. It is, of course, very absurd to take the cost of coal, lime, and energy, and calling that the cost of the carbide, to compare the cost of a candle-power-hour with that of gas as charged to the consumer. The prime cost of gas delivered into the "hydraulic main" would be the right thing to compare in such a case and would tell a very different story. On the other hand, the distribution of acetylene may well be much more simple in proportion than that of coal-gas. If it is to be delivered by pipes its only advantage, as far as distribution is concerned, is that the pipes will be smaller. This would make but little difference in the total cost of distribution, as it only reduces the capital sunk in mains a little. The cost of laying them would not be very much reduced.

The first thing is to get some idea of the cost of calcium carbide. The estimates given vary enormously, as very little has been published as to actual cost of manufacture. It seems probable, however, that the cost of manufacture—that is to say, the cost of lime, coke, carbons, labour, and energy, taking energy at a farthing per kilowatt hour, will be a little over £6. If water is used, the price comes out a little lower; but, as already explained, water-power must not be reckoned upon too much, as rents will probably go up soon. It is best to be on the safe side, so we may perhaps take £10 a ton as the final price of electrically-made calcium carbide, capable of giving five cubic feet of acetylene per pound, packed and delivered on rail, after paying manufacturers' profits and all charges. This seems a low price, and it may be said that the various aluminium works have all the plant ready, and know exactly the cost of manufacture, and have reduced the price as far as it will go already. The business has really hardly commenced, however, and there is little doubt that the processes will be cheapened. At present, it is the roughest and crudest method imaginable.

Let us assume the final price to be £10 a ton, and see exactly what its future may be at that figure. Allowing five cubic feet of acetylene per pound, this gives, in round numbers, 18s. per 1,000 cubic feet. Calcium carbide is not acetylene, however. Suppose the treatment with water raises the acetylene to 20s., and that it gives 20 times as much light as coal-gas, it would then correspond with gas at 1s. per 1,000 cubic feet. Now, let us look at the price of gas. A ton of coal at, say 10s., gives 10,000 cubic feet of gas; so gas should be 1s. per 1,000 cubic feet. But the ton of coal gives 15 cwt. or so of gas coke, which is worth something, and over 100 lbs. of tar, which is valuable, and 20 gallons or so of ammonia liquor. Some of the 15 cwt. of coke is used to heat the retort benches, and labour, &c., has to be paid for, but still the actual value of gas at the hydraulic main is really only a few pence per 1,000 cubic feet, and acetylene has no chance in comparison. The common practice of taking the price—generally the prime cost—of carbide of calcium, reckoning from it the price of acetylene, and comparing it with the price of delivered coal-gas is absurd. In addition, the great difference in lighting power comes in when the acetylene burner, though using little gas, is giving a very powerful light. Except in sitting-rooms, people want small lights about their houses, and they want to be able to turn them down at will.

Acetylene may be used for enriching coal-gas. Whether it will pay depends very much on the local conditions. Cannel coal is usually employed when enrichment is necessary. The prime cost of gas at any works depends on the price of coal and labour, and on the selling price of coke, tar, and ammonia. The cost of scrubbing and purifying would have to be incurred in making acetylene on the large scale, and the cost of distribution by pipes and collection would be about the same in both cases. It is impossible, however, to give any answer as to whether it would pay to enrich coal-gas, unless one knows the real cost price of gas in a given case. Thus to take a rough example, suppose crude gas costs 6d. a thousand cubic feet; so that acetylene costs forty times as much. Adding 3 per cent. of acetylene would about double its lighting power, so that to replace 1,000 cubic feet of gas we would have 500 cubic feet costing 3d., and 15 of acetylene costing over 3½d. It is therefore clear that it will not pay to enrich with 3 per cent. of acetylene at these prices. I have not worked out figures to find the best enrichment for each relation of values of acetylene and coal-gas, for it seems clear that unless the cost of carbide is much less, or the cost of crude gas much greater than here assumed, there is no chance of its being utilised in that way. A public company does not make improvements if it can help it, and of all public companies gas companies, owing to their constitution and the sliding scale arrangement, are least likely to adopt such methods as enriching gas, even with the bye-products of electric lighting companies, who make carbide to get decent load factors.

In addition to this, gas is not used only for lighting. It is very largely used now for heating purposes, and the incandescent mantle has come to stay, and people with stoves and Welsbach burners would strongly object to having their gas bills doubled, and their gas contaminated with a body which necessitates their renewing all their gas fittings and removing all copper and brass taps and couplings.

It does not look, therefore, as if acetylene will compete with gas at present. It may be a different matter in other countries. In the United States, for instance, gas is generally very dear. I had charge of a works in Boston some years ago, and we paid 10s. per 1,000 for gas. One shudders to think what it must cost in outlying districts. The enormous strides made by the electric light in America is not owing to the good electrical engineers, but to the bad gas producers. Perhaps the gas works are run by the urban authorities; this wou account for anything. If sulphate of ammon does not fetch good prices in America, and tar distilling and the manufacture of dyes is n brought to the perfection they are in Europ it is quite probable that acetylene has a mu greater future there than over here, especia as in proportion to the inhabitants water pow is much more plentiful, so that power pric may remain low for a very long time.

The next scheme is to deliver calcium ca bide to houses, and let the consumers ma their own acetylene. All that is needed is add water. This sounds very simple. In t beginning of the century gas was to be ma on the spot in the same sort of way. All y did was to put coal in a retort, and heat and off came the gas. Yet this was nev practised, except in special cases, and ga never came into use generally until it wa distributed by pipes ready for use. There ar of course, a few country houses and isolate establishments where they make a fluid the call illuminating gas. Exactly the sam thing happened with the electric light. Eac house was to have a gas-engine and dynamo, and generate its own power. The the next idea was that the accumulators wer to be left at the houses with the milk, an changed next day or week or month; but th never came into practice either. These tw schemes correspond very fairly with those distributing carbide for use in generators, an distributing liquid acetylene in bottles. Th generators would always be troublesome in a ordinary house. No doubt the light would b much cheaper and better than that of gas, a commonly used, but that is by no means every thing. People forget that the average house holds are controlled by women. Women ma understand people, but they are complete wanting in the faculty of understanding things and they have the unreasoning conservatism and conventionality belonging to the unde veloped mind as seen in boys and savages A woman hates everything new, and woul never understand how to work an acetylen generator until it had been in use for genera tions, and it was considered part of the dut of a good housekeeper to make good acetylene as it used to be to make good beer. Of cours even then it would be done by rule of thumb There is more than this. The first thing a woman asks when she sees anything new, b it a mousetrap or a telephone, is, "Will i explode?" Now no one can say on his honou that an acetylene generator won't explode e does not think it will, in fact he feels sure won't, and he sincerely hopes it won't, but n explosion might possibly occur. This settles e matter. The only thing to be done would to utilise a woman's instinctive hero worship nd belief in authority, and to arrange that cetylene generators should be recommended y her clergyman or doctor. I say her doctor dvisedly, as she does not believe in other omen's doctors.

The plan of distributing liquid acetylene in on bottles sounds more promising, as very ttle goes a long way, and the bottles could be onnected to the house service by the acety- ne company without the women of the house aving anything to do with the matter. Acety- ne is given off on the addition of water to he carbide, at enough pressure to liquefy in a old bottle at once, and it might be purified at he same time. It must be remembered, how- ver, that the comparison must be made, as to ost, not with gas burned in the ordinary atswing burner, which is generally not even ood of its kind, but with the incandescent antle. If anyone is going to improve his ghting, he will not take up acetylene, as gainst the incandescent burner, unless it is etter. Acetylene gives, for a cubic foot, bout three times the light of the Auer burner, o that, at 20s. per 1,000 cubic feet, it corre- ponds to gas at 6s. 9d. Gas seldom costs s. 9d. per 1,000. Besides, it is easier to put the Welsbach burners; but if a considerable lteration is to be made, the electric light may e preferred.

All the same, there is a very large opening or acetylene, apart from competition with coal- as. For country houses, and in carriages, mnibuses, trains, and on board ship, it ought o have its own way. One of the chief things anted is a good burner, that will not give muts under any conditions.

A good portable acetylene lamp is also much eeded. If the lamp generates its own acety- ene there is the difficulty of having it attended o properly, at least by maidservants. Even araffin lamps are seldom in good order where here are no men servants, and the old colza il lamps never were. There are other diffi- ulties however. The action of the carbide on he water is so energetic that each time they ouch too much acetylene is given off, and some ort of gasholder is needed. I have tried ixing alcohol with the water to reduce the igour of the action, and it works fairly well. I ave lately found that this plan has been lready fully worked out. Another difficulty is that the water gives off vapour which generates acetylene, so that when the lamp is out of use acetylene is being generated slowly. This means that the lamp will smell, and the smell of acetylene is not pleasant.

Small bottles of liquid acetylene for portable lamps should be no more difficult to deal with than mineral-water siphons, and a small steel tube bottle would run a light and portable 10 candle-power lamp for a long time. The want of portability is the great drawback to gas. The electric light is a little better, but not much. The result is that candles are still used. Acetylene lamps would not ruin the carpets, or cement the piano keys together.

Too much has been generally said about the poisonous nature of acetylene. Experiments show that it is not at all a serious poison, and its smell is a great safeguard. It uses so little air in burning that, on the whole, it would be a very much more healthy illuminant than gas, oil, or candles, especially if it contains no sulphur. Healthy breathing is not generally sufficiently appreciated yet. Many people still sit in close rooms and sleep with their windows shut, and the smaller air consumption of acetylene would not really appeal to them very much. Besides, according to experiments recently made on polluted air, the evils of vitiated atmosphere have been greatly exaggerated. Though acetylene, like carbon disulphide, is an endothermic compound, it is not easily exploded. Fulminate of silver only fires it locally. The explosion does not spread. Carbon disulphide explodes under curious conditions. If some is put in a bulb, and an air-pump connected and used, it will go off. I do not know if acetylene has any analogous properties.

Calcium carbide may come to be used in the manufacture of alcohol, benzene, and other organic products, but it is too soon to prophesy its future in these directions. A great deal must depend on its price, and one of the chief items is the cost of electrical power. It is to be hoped that it will soon be made by non-electrical methods, and its price may then be reduced considerably.

Miscellaneous.

FIELDS FOR RAILWAY ENTERPRISE.

According to a recent American report, the field for railway building which the vast continent of Africa offers is destined to witness great activity.

With an area of 11,500,000 square miles, or nearly four times that of the United States, omitting Alaska, and with a population of 168,000,000, the entire continent has only 8,000 miles of railways, against the 181,000 of the United States. The few lines that foreign enterprise has already built lie almost entirely near the extreme north or the extreme south coast, with a few miles on the west coast; while the vast interior is unpenetrated, and transportation on the dark continent, as a whole, is still being done on the backs of men. But the change has commenced. The construction of the Uganda Railway, a line 600 or 700 miles long, from Mombassa, on the Indian Ocean, inland, to the north shore of Victoria Nyanza, is decided upon. This road will open to the world's commerce a fertile country swarming with 20,000,000 people. Germany will not be much behind. Already it is announced that the Government propose to build a railway from Dares Salaam, a point on the Zanzibar coast some 250 miles south of Mombassa, westward to Victoria Nyanza, with a line also to Lake Tanganyika, lying still further south of the equator. This enterprise means something like 1,000 miles of road. China also is preparing for a railway era. Three lines are, it is stated, already decided upon—from Pekin to Tien Tsin, 80 miles; from Pekin to Hankow, a distance of several hundred miles; and from Shanghai to Loochow, about 65 miles. Corea, the Hermitland, is to seclude itself no longer, for an enterprising syndicate of Americans has been given the right to build a railway from Seoul, the capital, to Chemulpo, the chief port, and to work the minerals along the line; and other concessions have been granted to France and Russia. Long before the present century closes railway builders and operators, and the makers of railway supplies, will find large fields inviting their activities.

HORSELESS CARRIAGES.*

The wisdom of this year's change in the British legislative enactments with regard to traffic of this kind would be certain to make itself apparent in the near future. Hitherto, such developments as had taken place in this branch of engineering had been mainly outside of our own country; but this subject was destined soon to become among us one of great industrial importance.

Three centuries ago there was produced at Nuremberg a car propelled by the energy of coiled springs. The descendants of that machine might be seen today, in the clockwork toys which ran about the edge of the pavements in Cheapside, to the amusement of young folks and country visitors. A patent *char volant* made the journey between Bristol and London in 1826 with two passengers. The first steam road carriage was the invention of a Belgian, and was
constructed, in 1769, in the form of a long trolley
the transport of heavy ordnance. Several subseq
motor cars were fitted with an imitation of hor
legs, with knee-joints and hoofs, for pressing
rails; but this adjunct was soon found to be unne
sary. Hancock's later line of steam omnibu
running successfully between Paddington and
Bank, was noticed; but changes in the law, and
rapid introduction of railways, discouraged a c
tinuance or extension of that system.

On this side of the Channel we should now t
up the movement in a mercantile spirit, and ste
as a mode of road propulsion, which had b
largely laid aside on the Continent, would be m
commonly used in this country. Petroleum and g
engines would not be neglected, for the field oper
both was enormous. But, whereas we were in
position to construct at once steam-propelled vehic
whether for light or heavy loads, much still remai
to be done in regard to petroleum-propulsion bef
either heavy loads could be carried or passeng
conveyed free from vibration and offensive exha
tions, or with the degree of comfort associated w
horse-drawn vehicles. The Briton's love a
admiration for the horse would continue, and t
horses would not be discontinued for personal tra
port or pleasure excursions until some auto-mob
was invented whose movements could be regulat
by the pressure of a rein or by a whisper or chirp
the part of the driver. The requirements of tra
and commerce, and not those of pleasure or spo
would be the direction to which the engineers
motor cars would first devote their attention. T
value of good horses had greatly increased, instead
diminished, since it was predicted, when railwa
superseded the stage coach, that our equine bre
would decline.

With regard to electric cars, there was need for
light, compact, and efficient accumulator which wo
be indestructible by the ordinary vibrations of a ro
locomotive. There was, nevertheless, great scope f
electric motors in districts where there was a cent
station. The waggonette type of carriage lent its
to mechanical propulsion.

Although there had been an enormous extensi
of our railway system within a comparatively sh
period, there remained a vast and ample field f
travel and transport by means of mechanically-pr
pelled road carriages. There still existed in th
country considerably over a hundred thousand mil
of good turnpike roads, and a large proportion of th
mileage was represented by roads connecting towns
a considerable distance from railway stations. Su
towns and outlying districts could be far mo
effectively served by a judiciously organised syste
of horseless locomotion than by light railway
Horseless locomotion was in many essential respec
much cheaper than our present system. Besid
which, motor cars would obviously effect sanita
and hygienic improvements, as well as diminution
the noise attending urban horse traffic.

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[*] Abstract of a paper read by Mr. A. B. Sennett before Section G (Mechanical Science) of the British Association.

THE HOP INDUSTRY OF AUSTRIA-HUNGARY.

Among hop-producing countries Austria-Hungary ds a very prominent place, the production repre- ting, on an average, a tenth part of the total pro- tion of the world. According to M. H. Lozé, nch Ambassador at Vienna, Bohemia is the most ductive part of Austria for hops, furnishing the t kinds, and two-thirds of the crop of the king- n. The hop gardens of Bohemia are situated in neighbourhood of the towns of Saaz, Rakonitz, n, Auscha, and Dauba; and of these the Saaz rict is the most celebrated for the quantity and lity of its production. The central point is the n of Saaz, situated in the north-west of Bohemia. e cone of the hop is very thick, and usually from to 45 millimetres in length. It is said to have no al as regards aroma, though its agreeable, better ct may be equalled in Bavaria. In the district of konits, which is a town to the south-east of Saaz, l especially in the suburbs of Strakonitz, an ellent hop is grown, which does not differ essen- ly from the Saaz kind. In the south of Rakonitz re are districts where the cone of the plant is cker and rougher, and inferior in aroma and taste, the plant still retains the characteristic of the az variety. Further on, towards the south-east, kinds which have nothing in common with those Saaz. In the Lann district there are about a en plantations of hops, and the product may be ssed with the good sorts of the Saaz district. The portant Auscha district is in the north of Bohemia, the east of Leitmeriz. The cone of this hop is y handsome, often very rich, and has a fine aroma, l bitter flavour. The beer made from it has a dy sale. The Dauba district is also in the northern t of Bohemia, and the hops there are singular in n and completely different from the other Austrian ds. The cone is full and thick, and its value is siderably lower than that of the Saaz and Auscha ds. It serves in the manufacture of beer intended keeping. It is useless for the making of the best r, but can be used in conjunction with good hops ing to its clarifying qualities. After Bohemia ne the other Austrian provinces. In the east and st of Galicia very good crops are grown; the nts come from Saaz, and their aroma and bitter- s clearly show their origin. Some of these varie- s are so like those of the Saaz district, that only a noisseur can tell the difference. The hops of rth-eastern Styria (Furstenteld) and its environs ve this peculiarity, that they ripen quicker than other European hops. The picking generally gins in the middle of July, and the hops are on the rket about the end of the same month, at a time en the majority of other hops are only in full om. In Southern Styria the conditions are much same as in the northern district. In Moravia, p growing is of comparatively recent date, and ncentrated round Frischitz. The hop gardens of Upper Austria are Neufelden and Rohrbach. Here the species of plants are not all the same, and this may also be said of the products. In Carynthia, as in Moravia, hop-growing is of recent date, the principal centre being the district of Saint Veit. Besides the localities just indicated, there are in the lands of Prince Schwarzenburg, in South Bohemia, districts which yield a very good description of hop from Saaz plants. In Vorarlberg, and in the province of Salzbourg, hops are also grown, but on a small scale. With regard to Hungary, the crop of hops in 1894 represented more than one-fifth of the whole crop of the kingdom. Hungarian hops are grown from plants from Saaz, England, and Wurtemburg. They are cultivated in several Hungarian and Transylvanian counties, and are found also in Croatia. The conditions of the soil are generally very favourable in this part of the kingdom, and the result is often good crops, which show the origin of the plants. The total production of Austria, representing an amount of 114,000 quintals, is divided among the various provinces as follows:—Bohemia, 75,120 quintals; Galicia, 5,715; Styria, 5,540; Moravia, 1,999; Upper Austria, 1,165; Carynthia, 60; and Hungary 24,401 quintals. The Austrian breweries do not consume the total crop of hops. It is estimated that about 55,000 quintals suffice for their wants, that is, for the production of 14,000,000 hectolitres of beer. A margin is thus left for exportation. In 14 years (1881-94) the amount exported has reached 399,974 quintals, of a value of 82,000,000 florins, or an annual average of 28,569 quintals, worth 5,875,143 florins. On the other hand, Austria-Hungary has imported in the same period a total amount of 138,809 quintals of hops, of a value of 28,000,000 of florins, or an annual average of 9,915 quintals, valued at 2,000,000 florins.

Notes on Books.

DETECTION AND ESTIMATION OF INFLAMMABLE GAS AND VAPOUR IN THE AIR. By Professor Frank Clowes and Boverton Redwood. London: Crosby Lockwood and Sons. 1896.

The researches of Professor Clowes and their practical application for the detection of small amounts of inflammable gas in the air are well known to members of the Society through the communications which Professor Clowes has made on several occasions to the Society. His original object was to replace the rough and ready method of testing by a safety lamp by something more accurate, and this he has achieved by the application of the small cap which surrounds a flame of hydrogen burning in an atmosphere charged with gas. Professor Clowes has described to the Society the portable arrangement he has devised for the purpose, consisting, in the main, of a safety lamp in which a small hydrogen flame takes the place of the ordinary illuminating flame, the hydrogen being supplied from a small cylinder charged with compressed air. The apparatus, originally intended for use in coal mines alone, has been, with several modifications, adapted to the detection of other gases than marsh gas, which is the cause of explosions in mines. Among these applications, one of the most important is that devised by Mr. Boverton Redwood, in conjunction with Professor Clowes, for the detection and estimation of small amounts of petroleum vapour which had been left in the tanks of steamships employed for the conveyance of the oil. Many serious accidents have happened from this cause, some of them even after the oil tanks had been apparently cleared from all vapour, and the necessity is therefore obvious of some means of testing the atmosphere of such tanks before workmen are allowed into them with lights, or even with hot rivets for the purpose of repairs.

In many cases the ordinary safety lamp is not entirely suitable, especially in cases where it is desirable to remove a sample of the suspected atmosphere and test it away from the tank itself. It is for this purpose that the apparatus, a full description of which is given, has been constructed.

Another application of the invention is to the testing of air in electric mains, which, as is well known, sometimes become charged with coal-gas owing to leakage from neighbouring pipes. Here, again, the conditions are different, and a different apparatus was necessary, what was required being a means of sucking the air from the suspected conduit, and supplying it in place of the atmospheric air to the lamp. Such an apparatus is also described in the book, and it is stated that it has been successfully used on several occasions for the purpose of testing electric mains in London. Besides these appliances of Professor Clowes and Mr. Redwood, the book gives descriptive accounts of the various other devices which have been made for testing the air of mines, such as that of Liveing's, in which the appearance of an incandescent spiral platinum wire surrounded by ordinary air and that of a similar spiral surrounded by suspected air is compared; Ansell's diffusion apparatus, in which fire-damp is allowed to diffuse through porous material into a closed vessel of air, the resulting increased pressure being measured; Forbes dampOscope; the Hardy detector; and other devices.

EARLY WORK IN PHOTOGRAPHY. By W. Ethelbert Henry. London: Dawbarn and Ward, Limited. 1896.

This is an elementary text-book intended to give instruction to those who are taking up the practice of photography. It will be found useful, not only by those who are entirely ignorant of the subject, but by those who have already had some practical experience of the work. A special feature of the book is that a standard negative with a transparency made
from the same, both on celluloid tissue, are provide
so that the beginner can have a standard by which
test his work. A protest may be permitted again
the use of the foolish and entirely unnecessary wo
"photogram" in place of the ordinary "phot
graph."

General Notes.

BULGARIAN SERICULTURE.—The French Cons
at Rutschuck says that the first cocoons of the 18
yield have recently made their appearance on the ma
ket, the greater part white, but a considerable quanti
also of yellow cocoons. The yield was about
kilogrammes of cocoons per ounce of seed. The yie
is said to be a fair average one; that is to say,
exportation about equal to that of last year is anti
pated. The total production of cocoons in Bulga
was 3,600,000 kilogrammes in 1894, and 4,000,0
in 1895. The exports amounted to 91,992 kil
grammes in the former year, and 105,568 kil
grammes in the latter. Of the amount exported
1895, 42,000 kilogrammes were consigned directly
France, 47,000 kilogrammes to Turkey, 11,000 kil
grammes to Austria, and the remainder to Italy.
should be observed that a part of the consignmen
to Turkey were intended to be finally shipped
France and Italy.

THE CONSUMPTION OF COTTON GOODS
AFRICA.—According to the *Handels Museum*, the
is an ever-increasing consumption of Americ
cottons in Africa, considerable quantities having be
imported during the last four years. During l
year, 26,250,000 yards of coarse American cott
tissues were imported. It is principally the e
coast which has offered the best market for th
goods, while the markets of the west coast
monopolised by English and German houses.
the coast of the Red Sea, as far as Somali, Americ
cottons are in great demand. The uses of the
articles by the natives are very simple and primiti
To cover their nakedness, they take a piece ab
12 yards long, which they roll round their lo
bringing it over the right shoulder, and fastening
to the girdle. A tissue of somewhat finer descr
tion is used as a mantle or tunic, and this kind
article does not, it is said, cost more than a f
pence. Cottons were formerly shipped in bales
sailing vessels, and in small quantities, according
the demands at the place of consumption, but t
method of transport has of late completely chang
At the present time cottons are shipped on steam
and in much larger quantities. The vessels unlo
at Aden, where the distribution of the merchand
is effected for the various parts of the east coa
American cottons have, it is said, a brilliant fut
before them, not only on the east and west coasts
Africa, but also in the interior of the dark contine

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FRIDAY, OCTOBER 9, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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EXAMINATIONS, 1897.

The dates fixed for the Society's Examinations in 1897 are Monday, March 22nd, Tuesday, 23rd, Wednesday, 24th, and Thursday, 25th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post-free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

PRACTICAL EXAMINATIONS IN MUSIC.

These Examinations will be held at the Society's house only, and commence on Monday, 21st June (Examiner, John Farmer, Balliol College, Oxford, and Director of the Harrow Music School; Assistant-Examiners, Ernest Walker, M.A., Mus.Bac.Oxon., and Burnham W. Horner).

The Examination will be Vocal and Instrumental. For the piano, violin, violoncello, and organ, there will be four standards, and corresponding certificates will be granted. Candidates who pass with distinction in the first, second, or third standard will have the fact ecorded on their certificates.

Successful candidates in the fourth standard will pass or pass "with honours," according to the proficiency they display, and in very pecial cases of merit will receive the Society's Bronze Medal.

In singing, and those subjects not specially provided for, there will not be separate standards, but certificates will be given stating hat candidates have "passed" or "passed with distinction," and in the case of those who show special proficiency medals will be granted.

Further particulars can be obtained on appliation to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Miscellaneous.

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TECHNICAL EDUCATION.

At a meeting held on the 2nd inst. in St. George's-hall, on the occasion of the distribution of prizes to the successful students at the Liverpool School of Science, Technology, and Art by the Lord Mayor of Liverpool (the Earl of Derby), Mr. W. H. Preece, C.B., F.R.S., delivered the following address:—

It gives me great pleasure to take part in this very interesting ceremony. The numbers present indicate great educational energy in Liverpool. It is a healthy sign. The apathy for technical education has been broken. The awakening of England is very pronounced. Gigantic strides forward have recently been taken, and nowhere is this more evidenced than in this country and in this great city. You have splendid schools, a magnificent college, and a scientific and technological organisation that is very much alive. You are supported not only by Imperial and municipal grants, but you owe a great debt of gratitude to the patriotism of those wealthy and philanthropic inhabitants who have so cheerfully opened their purses to further the movement. I wish we had such men in London as the Walkers, the Rathbones, and the Hofts. What is science? It is the A B C of nature. It is organised common-sense. It is a knowledge of the elementary facts which have built up this earth and all that therein is, and of the simple laws that govern its career through space. It is the gift that enables us to read, even while we run, those easily deciphered pages of nature that ever lie open before us when travelling on rail, road, river, or sea. The gentle rain, the noise of many waters, the wild fury of the storm, the brilliant flash of lightning, the ever changeable sky, the heaving ocean, the picturesque mountain, the carved valley, the orbs of heaven—life in all its forms, from the infinitely little to the immeasurably great—are never-ceasing subjects of interest, excitement, and thought. As Longfellow wrote:—

> "'Come wander with me,' she said,
> 'Into regions yet untrod,
> And read what is still unread
> In the manuscript of God.'"

Science is not only a source of pleasure and of reverence, but it is the mainspring of individual usefulness, the soother of manual labour, the great benefactor of hearth and home, and the originator of all those improved processes of art and of manufacture that have characterised this great Victorian age. It is the root from which grow health, comfort, and wealth. What is technical education? Lord Playfair once said that a telegraphist who knew nothing of electricity, or of the principles upon which the instrument he worked was constructed, was simply "an ambidextrous monkey." A workman is but a dull machine if he does not know the "reason why" of every operation he performs. An artisan misses a new sense if his mind does not grasp the principles that guide his art. The manufacturer is groping in the dark if he does not avail himself of the light of science. Technical education teaches the principles of the science and art of industry and manufacture. Art is to do, science is to know. Technical education does not propose to make the workman in Lever's soap works a chemist, nor an artisan in Horwich a physicist, nor a sailor on board the *Lucania* a navigating officer, nor a soldier in the ranks a general. It is meant to supply intelligence to direct and hasten manual labour, and to excite interest and pleasure in one's work, whatever it may be. It explains the cause of action in every operation and the principles of construction of every machine. It furnishes food for thought, it promotes observation, it encourages reflection, it prompts new ideas, and it invents new processes. It proposes to make every labourer in every field, and of every class, a better, smarter, and wiser worker. It is wanted as much in the parlour as in the kitchen, in the office as in the workshop. In fact, I go further, and say that it is wanted more in the employer than in the employed. We have to brush away ignorance and apathy in high places. I have never found a lack of enthusiasm in the lower ranks. Inertia exists principally in the higher ranks. The employer can look after himself. The employed must be looked after, and, thanks to foreign competition, he is at last. We are a very conceited nation. We are saturated with success. The supremacy of our industries, the monopoly of the manufactures and trade of the world, and the acquisition of wealth have blinded us to the proceedings of other countries. Exhibitions have opened our eyes. The German, the Swiss, and the Frenchman, in their race against England, saw the necessity for technical education long before we did, and supplied the want. The German science teacher is found everywhere, not only in our colonies, but in England itself. For nearly half a century she had the export trade of teachers in her own hands. What wonder that German trade has dealt us a rude blow? The German is a very active competitor. He is a business man of great merit and activity. He understands the power of advertising. His emissaries are everywhere. He is, however, doing us a great service, for he has opened the eyes of the powers that be in this country to our neglect in the past, and he has thus given a tremendous impetus to scientific education at home. The danger is that this German bogy will drive us to foolish extremes, and cause not only waste of money, but loss of energy and produce valueless work in wrong channels. Immense sums have recently been allotted by the Government for technical education. Has the distribution of this money fallen into right hands? Have our county councils, who are principally concerned in this operation, themselves been educated into the merits and demerits of the question? What ought we to do? I think that we should commence at the bottom simultaneously with our efforts at the top. The rudiments of mechanics, the basis of a science, should be taught in every elementary schoo and the eye trained to observe from the earliest year Notions of length, of mass, and of time; how t measure, to weigh, and to calculate; ideas of motion velocity, inertia, momentum, and energy cannot to early be imbibed. They are illustrated in childs sports and games. Cricket, marbles, hoops, foo ball, sliding, and cycling are object-lessons better tha laboratory experiments, and they are easily turned t account by the intelligent teacher. Text-books ar dangerous except for pupils well advanced. Professo Flinders Petrie said, "We are drunken with writing." This is too true of science. The facts of science an the truths of nature are open to all. As Shakespeare said—

> "Our life . . . .
> Finds tongues in trees, books in the running brooks,
> Sermons in stones, and good in every thing."

The apprentice in the workshop learns how to use his hands, the student in his class-room learns how to use his brains. The one course is manual, the othe is mental. The combination of the two is imperative to complete the education of the artisan. The brain is the most powerful element of success. Thus technical knowledge prepares the brain to assist and direct the hand. It teaches the simple duty of thinking for oneself. I have used the masculine gender, but those of the opposite sex who appea hear in such numbers must not assume that I am neglecting them. As a lecturer rather quaintly remarked—"In this department the male embraces the female." Sewing machines and cycles are making mechanics of our young women. The technical aptitude of our female telegraphists is quite astonishing. I am confining my observations almost entirely to the adult artisan, who is earning his living and is desirous to comply with the spirit of the age and the march o the times. How is technical knowledge best acquired by those of mature years whose education has been neglected? I advocate the encouragement of self-help, and the supply of every convenience to assist self-exertion and promote mutual co-operation. Gibbon said:—"Every person has two educations, one which he receives from others, and one, more important, which he gives himself." Artisans should be able to receive assistance and instruction in workshops devoted to their own trades by well qualified practical teachers. I do not believe in abbreviating or in endeavouring to supplant the practical training of the workshop. I want the artisan who spends his day at the bench encouraged and assisted in gratifying his ambition for "more light" by providing for him well equipped and well directed classes in the evening. In the Post-office we do not attempt to enforce science on anyone, but we supply an incentive to its acquisition by making promotion to higher grades dependent on the possession of certificates of technical proficiency, as well as of general merit. Books, class-rooms, and apparatus are supplied and prizes distributed for good positions in examinations, This voluntary system sifts out the ambitious, the ntelligent, and the wise. It separates the wheat from he chaff. The result is most satisfactory, for the efficiency of the service is a proof of the success of the methods adopted. It is only large establishments hat can do what we can do in the Post-office. Where here is a congeries of smaller establishments, as in Liverpool, such organisations as yours effect the same purpose. It used to be said that an ounce of practice was worth a ton of theory, and that we owe our mechanical success to the rule of thumb. "But the rule of thumb is dead," said Mr. Mundella. Practice must be combined with theory. We are holding our own in steam, in steel, in ships, and in electricity, because we have introduced the scientific method and have avoided the folly of the past; but there is still very much apathy, and there is a very strong impression that manufacturers as a class hate science. We have a good deal of agricultural depression. I visited last year Denmark—a cold, flat, bleak country, which would disappear if the tide rose as high as it does in the Severn. Yet this little country, wirh a population only one-third of that of Lancashire, sends annually £10,000,000 worth of farm produce to England. Why? The directed and instructed intelligence of the Danish farmer, and the introduction of the co-operative system beat the ignorant conservative and self-satisfied English farmer in his own market. It must not be concluded that technical knowledge is a panacea for everything. We can have too much of it. Jack may think himself better than his master and become too "cockey." We must, moreover, avoid overloading the brain and overtaxing the memory. A load of learning is apt to crush enthusiasm, and enthusiasm is the secret of all success. We can do no more than make a student an observer, an experimenter, a thinker. Time and patience, industry and intelligence, complete the task. Many imagine that a present of £20,000, a handsome building, and a well-equipped laboratory are all that are needed, but there is something even more important, and that is the supply of properly qualified teachers and directors of studies. This is the duty of our universities and colleges, and I think they are doing their work well. There is no lack of teachers now. Granting that we have teachers, money, buildings, and equipments, we still want enthusiasm, industry, and reward on the part of the students. We must maintain energy, encourage emulation, and supply impetus. Here comes in the prize, here comes in that friendly competition that stirs up personal rivalry. Here is the secret of our public schools, and of our national sports, and here we shall find the true functions of associations like yours furthering the national work, supervising the expenditure of grants, and redeeming the error of the past. The great war of the future will be of trade, of commerce, and of education. The battle will be to the best prepared, and to the best educated. Let us hope that our energies will not be misdirected, nor our energies misapplied.

FRENCH MOTOR CARRIAGE RACE.

So far as it has gone, the mechanical carriage race now in progress from Paris to Marseilles and back has afforded a good deal of conflicting evidence as to the capabilities of the new vehicles. Taking the results of the first half of the journey, without any reference to the various incidents on the route, the trials cannot be said to be altogether satisfactory. Only 11 carriages out of 32 were able to reach Marseilles, and in face of this somewhat meagre result, it may well be doubted whether the self-propelled vehicle has accomplished all that was expected of it. But there are certain features of the contest that may probably tend to modify this unfavourable impression. In the first place, the competition organised by the Automobile Club of France was a race pure and simple; it was intended to test the speed of the vehicles without taking into account the more solid qualities of economy, safety and ease of handling, which are so essential to the self-propelled carriage. It was precisely for this reason that certain makers objected to the conditions of the trials, while others sought to draw the greatest profit from them by constructing vehicles specially for the race with very powerful motors.

As speed was everything, the competitors were little disposed to exercise caution, and it is evident that an average rate of travelling of twenty miles an hour—which was accomplished the first day—cannot be kept up on the high roads without running serious risk of accident. Then on the second and third days, the weather was the worst that could possibly have been imagined for such a contest. A terrific gale blocked up the roads with trees and telegraph poles, and the accidents resulting from these obstructions, and the clogging up of exposed machinery by the mud, thinned out the ranks of the competitors considerably. It is thus hardly fair to accept the result as proving the inefficiency of all the vehicles which thus came to grief, as it is pretty certain that under less exceptional conditions some at least would have accomplished a creditable performance. Nevertheless, the race has shown up a great many defects in the present types of mechanical carriages, and has again proved, if proof were needed, that a carriage is not suited for every condition of running, unless the mechanism be thoroughly protected and raised well up out of the mud and dust.

The deplorable weather early in the contest is much to be regretted, because it has deprived the trials of much of their technical interest. The race promised to resolve itself into a struggle between the old types of vehicles and the new, that is to say, the perfected vertical motor and the horizontal engines with their improved gearing, which have been designed upon lines suggested by the previous trials. Of the former the chief representatives were Panhard and Levassor, who had entered four vehicles propelled by a powerful type of Daimler motor, while the new carriages were run by Peugeot and Company, who had abandoned the Daimler for a horizontal motor of their own invention; MM. Léon and Amedée Bollé, the former with his light tandem vehicles driven from the rear wheel by a horizontal motor, and the latter with a four-seated carriage propelled by a horizontal motor, and bevel geared to the rear driving wheel, and M. Emile Mors, who likewise had a horizontal motor of his own invention. Apart from these carriages there was little of special interest in the vehicles that assembled on Thursday, September 24th, on the Place de l'Arc de Triomphe, preparatory to the run to Versailles, where the start was to be made.

After the usual police formalities had been gone through, the carriages started for Versailles in the presence of a large crowd of spectators. Most of the vehicles ascended the long and steep gradient at Suresnes in a satisfactory manner, though several of them had to stop a few minutes to effect slight repairs. A Bollée vehicle and another were stranded on the way, and had not reached Versailles when the starting signal was given. The Dion steam tractor, driven by the Count de Dion himself, created an impression by dashing up the gradients at full speed, leaving a good deal of vapour in his wake; but it is difficult to see how this compromise between a traction engine and a locomotive can come under the category of self-propelled carriages, or that it is suited for any other purpose than that for which traction engines are usually employed. The light Bollée vehicles and the petroleum tricycles, which had failed so conspicuously the previous Sunday in the bad weather, showed that they were capable of performing very satisfactorily under better conditions; but, as will be seen further on, the Bollée vehicles again succumbed when the storms had made the roads heavy and muddy.

There were several thousands of spectators on the Place d'Armes at Versailles to see the vehicles start on their long journey to Marseilles and back. The first day's stage was at Auxerre, where the vehicles had to put up for the night under official observation, to prevent any repairs being effected. In fact, competitors had to carry out all their repairs on the road; and once the carriages were entered as having completed the day's journey, they were not allowed to be touched. The same rule was rigidly observed at the following stages: at Dijon, Lyons, Avignon, and Marseilles; and the times each day between the start and the entering of the yard was added up, to give the time for the full distance ot 1,700 kiloms. After seals had been attached to various parts of the vehicles at Versailles, they were sent on their way by Count Henry de la Valette.

Some delay was caused by the first vehicle, belonging to M. Fisson, running over a man, but when it was found that his injuries were not serious, the others were despatched at intervals of a minute. Altogether, there were thirty-two vehicles, belonging to the following makers:—M. Fisson, of Paris; M. De la Haye, of Tours; the Maison Parisienne des Voitures Automobiles, Penhard and Levassor, Peugot et Cie., Count de Dion, Amedée Bollée, of Le Mans; Lebrun, of Paris; Landry and Beyroux, of Pari Rossell, of Lille; Triouleyre, of Paris; Leon Boll of Le Mans; Rochet and Schneider, of Lyon Tissandier, of Paris; and Tenting, of Paris. The were twenty-seven petroleum carriages, including t light Bollée tandem vehicles, three steam vehicl and five petroleum tricycles. All three of the stea vehicles were propelled by the Dion system of gen ator, and in view of the almost entire abandonme of this power by the French mechanical carria users, the small proportion of steam vehicles in t race is not surprising.

Hardly had the last vehicle been sent on its w than news arrived that No. 5 Panhard and Levass carriage, with which the firm expected to win t race, had been stopped through the rubber ti slipping off one of the wheels, and about an ho was lost in effecting repairs. At first it looked as the first day's stage would be an easy victory for t Dion steam tractor, for this vehicle travelled at remarkable rate until a little beyond Melun, when was stopped through the pneumatic tires puncturin Considering the weight of the vehicle, the idea employing air tires was peculiar, to say the least, an they were damaged to such an extent that there w no possible hope of repairing them. Count de Dio had therefore to give up the struggle, and it was onl after infinite trouble that he succeeded in getting th cumbrous machine to the nearest town. The othe steam carriage, driven by Count de Chasseloup-Lauba also came to grief through a defect in the mechanism and several hours were spent in taking it to piece and endeavouring to put it together again. Not on of the steam vehicles was able to cover the first day' stage. This is somewhat unfortunate, as it tends t throw more discredit on steam than is warranted The vehicle to arrive first at Auxerre was the tande machine driven by M. Léon Bollée, which ha covered the 178 kiloms. in the excellent time o 5 h. 31 min. A Dion tricycle followed twenty minute afterwards, and then came another Bollée, wit Delahaye, Panhard and Levassor, and another Dio tricycle in that order, the others being a long wa behind.

The Peugeot carriages were delayed several times b the extinction of the burners, which caused the competitors considerable inconvenience, and, in fact, fe of the vehicles were found to be entirely free fro constructional defects. Altogether 27 vehicles reache Auxerre, some of them arriving during the night The following morning a violent gale afforded a ver unpromising outlook for the competitors, and, wit reports coming in that the roads were blocked up b fallen trees, it was proposed at first to abandon the contest. To this, however, the competitors would not agree, and the vehicles were sent off in the orde in which they had arrived the previous day. Very soon the soft and muddy roads told upon the low-down Bollée vehicles, which were obliged to stop through the mechanism becoming clogged up and deranged by the mud. M. Léon Bollée, who had won so easily on the first stage, had made a complaint to the committee to the effect that during the night someone had surreptitiously introduced emery powder into the bearings of his motor. Whether this was so or not, it is a fact that the piston and some of the parts were literally ground away. Then the carriage of M. Amedée Bollée crashed into a tree that lay across the road, and the four passengers were thrown a distance of 20 yards, though, fortunately sustaining no serious injury. The carriage itself was smashed to pieces. The Rossel carriage came to an even less inglorious end. It was being pushed up a gradient by the passengers, when, on arriving at the top, the gale of wind blew it backwards, and the passengers helplessly watched it go to its destruction in a collision with a tree. In fact, the trees were a constant source of annoyance and danger to the competitors. Some of the vehicles were driven into the fields in order to get round the obstructions, and M. Delahaye lost a couple of hours in cutting a way for his carriage through a fallen trunk. This was, indeed, a disastrous day for the mechanical vehicles, and of the 27 that left Auxerre in the morning, 16 only were only able to reach Dijon, some of them several hours behind the first arrivals. The first four places were taken by Panhard and Levassor, of which the first covered the 151 kiloms. in 6 h. 39 min. From Dijon to Lyons the conditions were scarcely less favourable, for the rain still fell heavily, accompanied by a strong wind. On this stage likewise, a few accidents took place, one of them of a serious character. The No. 7 Panhard carriage tried to avoid a waggon when passing through Villefranche, and in so doing ran on to the pavement, when the vehicle overturned. Three of the passengers escaped with a severe shaking, but the fourth was picked up with a broken nose and a wound on the forehead. Happily, it was found that the injuries were less dangerous than had been feared. The carriage was damaged, and apparently was not in a state to continue the race.

Notwithstanding the unfortunate weather, the leading vehicles accomplished a very good performance, and the No. 6 Panhard and Levassor carriage covered the 198 kiloms. between Dijon and Lyons in 6 h. 29 min., followed half an hour afterwards by a Peugeot vehicle. Fourteen vehicles reached Lyons, and there was a difference of no less than seven hours between the first and last arrivals. From this point the weather was much more favourable to the contest, and the run on the fourth stage, from Lyons to Avignon, was accomplished with a no more serious accident than the overturning of the No. 5 Panhard and Levassor carriage, which had run into a tree in trying to avoid a dog. M. Levassor and his companions were shaken, but sustained no other injury, and the carriage was intact; but it was decided, nevertheless, to give up the race. The first arrival at Avignon was the No. 46 Peugeot carriage, which had run the 227 kiloms. from Lyons in 7 h. 48 min., followed a few minutes afterwards by a couple of Dion tricycles. Thirteen competitors completed this stage, and the whole of them subsequently arrived at Marseilles, which was reached without any incident of any kind. As the weather was fine, and the competitors were assisted by a strong wind, very fast times were accomplished, and the No. 6 Panhard and Levassor vehicle covered the 109 kiloms. in 3 h. 6 min., or 67½ miles. That is to say, at the rate of nearly 21·8 miles per hour. The first ten vehicles did the distance in less than four hours. Adding the times for the first half of the distance, the leader is a Dion tricycle, followed by Panhard and Levassor and Peugeot.—*The Engineer.*

TRADE WITH VICTORIA.

In addition to what has appeared respecting "Trade within the British Empire" [see *ante*, p. 793], in reply to the despatch of the Secretary of State for the Colonies, a report by Mr. F. H. Bruford, of the Statistical Branch of the Department of Trade and Customs (Victoria), has been published in the *Board of Trade Journal*, from which the following particulars are extracted:—

It is a matter of common knowledge that by far the greater part of the foreign goods shipped to Victoria are received from British ports, and are entered in the statistical returns of the colony as from Great Britain: the statistical returns do not pretend to show the country of origin, and the return of direct importations from each country does not give, even approximately, the trade in the produce of that country.

According to the return, the per-centage of importations from foreign ports on the total trade on those goods listed in the despatch was as follows:—In 1884, 7·86 per cent.; in 1889, 11·17 per cent.; in 1894, 12·58.

An estimate, made after careful inquiry amongst the importers, and by one who has a knowledge of the goods passing through the Custom-house, shows that the foreign trade in the same goods in 1894 was 33·06 per cent. of the total. Of this, only 12·58 per cent. was received direct from foreign countries. This estimate applies to the articles included in the return only, and it must not be mistaken for a correct statement of the per-centage of the total foreign trade of Victoria. Tobacco, timber, wine, and many other goods which are not British products have been omitted, as also have all goods of which the foreign importations do not amount to 5 per cent. of the total importations.

Goods, before their arrival in Victoria, lose their identity, and it would be very difficult, if not impossible, to trace them to their plate of origin. Further, even when such goods are purchased direct from continental merchants they are commonly sent to England for shipment, in order that advantage may be taken of the cheap freights by British sailing ships, and for other reasons.

It is not only continental goods which come from Great Britain. American goods are sent by way of London on account of the freight facilities offered by the regular trade lines of vessels, and they are also purchased in England for the Victorian market.

There are other factors which tend to increase the total of British trade, as shown in the statistics. The whole of the intercolonial trade ranks as British, and much of this is simply the sending backwards and forwards and of merchandise to suit market requirements. British goods shipped to Sydney and thence to Melbourne would appear twice as British trade to Australia, once in New South Wales and once in Victoria. Foreign goods shipped by the same route would appear in New South Wales as foreign, and in Victoria as British. This interchange is carried on to a considerable extent; American, Japanese, and Chinese goods commonly arrive by way of the neighbouring colonies, thus being included in the statistics of Victoria as British.

There is a small *contra* reduction. A few Canadian goods come through the United States and are ranked as foreign.

Whether foreign trade, in proportion to the total commerce, has increased or decreased since 1884 or 1889 cannot be definitely stated, but it is the opinion of a majority of those best able to judge that there is no greater proportion of foreign trade transacted in Victoria than there was in 1884. In fabrics for women's wear, and some other articles, the continental countries have improved their position; in hardware and heavy fabrics the British trade has advanced; whilst in wooden goods the United States now, as heretofore, maintains supremacy in the markets of Victoria. Lately the trade in iron and steel has been threatened by the competition of Germany.

The selection of the years 1889 and 1894 for comparison has rendered the return to some extent valueless as an indication of the increase or decrease of foreign trade in this colony. In the year 1889, Victoria was at the climax of a commercial and speculating mania, and the imports were larger than at any previous period; in the year 1894, on the other hand, the colony was at the lowest depths of a time of depression, and the imports had fallen to a minimum. The total value of the goods included in the return was £9,379,679 in 1889, and £4,111,459 in 1894.

Whether British and Foreign trade were affected to an equal extent is doubtful. On the one hand, the importation of the many articles which are not necessaries of life—such as pianos, pictures, fancy goods, which are foreign manufactures—almost entirely ceased; whilst, on the other hand, the diminished incomes of the masses of the people led to the use of the cheaper continental manufactures in place of the better English goods.

Mr. Bruford has arranged some of his remarks under these headings:—Freight and subsidies to shipping. Terms of credit. Exchange. Marking of goods. Packing. Methods of transacting business. Price. Cataloguing and advertising.

Marking of Goods.—The enactment of the Me chandise Marks Act by Great Britain, and its adop tion by Victoria, has to a very great extent stoppe the sale in Victoria of foreign goods as British. Th effect of the statute is held by Victorian merchant to have been wholly beneficial to British trade. (Th Act, which was formerly known as the Merchandis Marks Act, is now Part II. of the Victorian Trad Marks Act, 1890.)

The Act, however, is evaded in several ways, an in spite of the law, some foreign goods are sold i Victoria as British. Many articles, partly made i Germany, France, and Belgium, are sent over t Great Britain, where they are finished and brande with the name of a British firm. This is known t be the case in regard to brass musical instrument and to guns and pistols. Probably the custom pre vails to a considerable extent, but it is too difficult o detection to enable any definite statement to be mad in regard to it. The guns and pistols, partly mad in Germany and Belgium, are stamped with th British test mark. The silver mountings of purses ladies' bags, &c., made in Germany sometimes bea the British Silversmiths' hall-mark, which is take by the public as an indication that the goods are o British manufacture.

A still more important evasion of the Trade Mark Statute takes place in regard to small boxed o carded goods. There is evidence that such article as pocket-knives are sent to Great Britain, probabl correctly marked on the box or card, "Made i Germany," but in Great Britain they are re-boxed o re-carded, and marked with a British firm's name These articles cannot legally be imported under th Victorian Trade Marks Act, but it will be at onc seen how difficult it is to detect or prove a fraud o this description. It is obviously much easier t administer the Trade Marks Act in regard to good coming direct from foreign countries than it is i regard to foreign goods arriving from Great Britain These evasions of the Trade Marks Act are distinctl detrimental to British trade, as the words "Made i Germany" are not in the colony any recommendation whilst an indication that goods are made in Grea Britain is generally looked upon as a guarante of honest workmanship.

Packing.—British exporters to Victoria generall attain the one object they appear to aim at in pack ing, viz., the transmission of their goods to thei destination without damage. The cases of suc goods as are cased are superior to continental ones, which are often too large and too weak, but in man other respects there is need for other methods tha those followed.

Firstly, sufficient attention is not given to th necessity of packing in a small compass. For trans mission to a distant colony this is important, becaus the smaller the cubic measurement in which good can be packed, the less is the freight, the storage, th cartage, the wharfage rates, and sometimes the duty. American goods, and sometimes German goods, are ore closely packed than British goods, without in ny way increasing the risk of breakage or damage. Vhenever a duty by measurement has been placed n any article in Victoria, it has been found that the mericans, and sometimes the Germans have proved hemselves able to place a greater quantity in a cubic oot than the British. The trade in lamp-glasses, ottles, and some other items has been seriously ffected by the difference in the closeness of packing.

A feature of United States packing is the more eneral practice of making up articles into trade ackages—that is, into packages which can be ought and sold in the cases in which they are mported. Clocks, lamps, and many such articles re sent in cases of unvarying size, and containing a suitable number of articles for sale to retail shopkeepers, when similar goods from the Continent or Great Britain would be sent in larger cases of irregular size, designed for no other purpose than to convey the goods to Melbourne.

Further, the United States use largely specially prepared pitch-paper for lining cases, where the British use metal. The experience in Victoria is that the pitch-paper is as effectual in preserving goods as metal, and that it is lighter and more convenient.

In the boxing, or "get up" of small goods, the United States manufacturers excel. They use cardboard boxes in numerous instances where the British pack in brown-paper parcels, and the United States practice is held to be preferable, for the reason that the box is suitable for placing on the shelves of a shop. As regards the goods which are packed in boxes, both in Great Britain and the United States, the boxing is nearly always better done in the latter country, the boxes being stronger and more sightly. British goods can commonly be picked out in the stock of a hardware store by the great number of broken boxes. The excellence of the Manila paper and card-board boxes used in the United States has been a considerable factor in advancing American trade.

Methods of Transacting Business. — Victorian merchants say that "the Germans bring their goods to the buyers, while the British wait for the buyers to come to them," and undoubtedly this is the experience of the colony. Large numbers of German manufacturers are represented by travelling agents, who display the greatest energy in transacting business; an energy which amounts to pertinacity. These agents live on less than the British, and they are not put to the expense of a large establishment or warehouse. Their own requirement for business is a simple room. They sell direct to retailers, and are content to take small orders, and to offer special terms for the purpose of making sales. As many houses buy in London only, the travelling agents make it their business to study the requirements of these houses in Victoria, and find out the buyers in London in order that the samples may be submitted there. They are constantly bringing forward close imitations of the saleable goods in the market a little lower in quality and in price than the articles copied. In all this their methods are in direct contrast to those of the British. There are travelling agents from Great Britain, the United States, and from other countries, but they do not equal those from Germany in energy or in pertinacity.

Cataloguing and Developing.—Some differences in the methods of advertising deserve attention. The British send to the trade catalogues, periodical price lists, and publications, whilst both the Americans and the Germans go beyond this by sending slips containing descriptions of every novelty and new pattern. A novelty produced in Great Britain is scarcely known in Victoria until it is superseded by another. Foreigners also advertise by sending trial consignments of new goods, a course which the British seldom adopt.

United States catalogues are very superior to British. The illustrations of articles are better, and the letter-press and general appearance are beyond comparison. As an example, it may be said that a collection of catalogues of bicycles was examined, the United States were much the best, the German the second best, and the British the worst. Some catalogues of British manufacturers printed in France were fairly good, but those printed in Great Britain were in bad taste as to the covers and general style, and were comparatively badly illustrated. This defect is believed to have an adverse effect on the sale of goods, especially when models are absent. The obverse side of this should also be shown. It is a frequent cause of complaint that United States and continental goods are not equal to the illustrations and descriptions, whilst the British catalogues are held to be more faithful representations of the articles offered for sale.

The American, and in some instances the continental catalogues give much more information than the British, not only in regard to the goods, but also in respect to other matters which are of importance to foreign buyers. These catalogues state the price at an available shipping port, the size of the packages in which the goods are packed, the weight of the packed articles, and such other information as is necessary. An intending buyer with these particulars before him can calculate with some precision the cost at which the goods can be landed in Victoria, whilst without them he may hesitate to give an order.

INDIAN PEARL FISHERIES.

The Ceylon and Madras pearl fisheries are each under the charge of a Government officer, who spends a certain part of each year on inspection duty, and keeps an accurate record of the condition at different times of the various banks. These officers regulate the fisheries, and permit fishing only when they consider the banks to be in a satisfactory condition. On the coast of Ceylon the fishing season is inaugurated by numerous ceremonies, and the fleet of boats then puts to sea. The United States Consul-General at Calcutta says that fishing, when allowed, generally commences in March, and lasts from four to six weeks, according to the season. The boats are grouped in fleets of from 60 to 70, and usually start at midnight, so as to reach the oyster banks by sunrise. Each boat generally caries two divers, and is manned by ten rowers, a steersman, and a shark charmer (*pillal karras*). On reaching the bank a signal gun is fired, and diving commences. To facilitate the descent of the diver, a stone, weighing about 40 lbs., is attached to the cord by which he is let down. The men work in pairs, one going down, the other staying on board and watching the signal cord. When this is pulled, the latter draws up the stone first, then the basket of oysters, and last of all the diver himself. Divers remain below, on an average, for from 50 to to 80 seconds, though some men can endure a much longer time under water. Exceptional cases, indeed, are recorded of men who could remain so long as six minutes under water. Each man makes 40 to 50 descents a day, and when exhausted is relieved by the watcher. Notwithstanding the fact that the water is infested with sharks, accidents rarely occur. The divers, however, always arm themselves with a short, pointed piece of ironwood for purposes of defence, and place implicit faith in the shark charmers. The constant life of exposure, excitement, and exhaustion in a tropical climate is necessarily a very trying one, consequently, the diver is a short-lived man. Work is continued from about sunrise to noon, at which time a gun is fired, and operations cease. On the arrival of the fleet at the shore, the oysters are thrown on the beach to putrefy, or are carried to the Government *kottus* at once, where they are divided into four heaps. The divers then receive their share (one heap), and the remainder is sold for the Government to the highest bidder. The oysters generally fetch an average of 30 to 40 rupees per thousand. After removal from the dead oysters, the pearls are classed by being passed through a number of small brass colanders, known as baskets, the holes in the successive baskets being smaller and smaller. Having been sized in this way, they are sorted as to colour, weighed, and valued. The little mollusc, known locally as *suran*, is probably the greatest enemy of the oyster. It clusters in dense masses over large areas of the sea bottom, spreading over the surface of coral blocks, smothering and crowding out the recently deposited and delicate young of the oyster. From experiments made with divers equipped with diving helmets, gathering stones instead of oysters, it was calculated that a pair of divers with this dress could together send up 12,000 shells an hour in shallow water, or, allowing for delay in hauling up in 12 fathoms of water, say 9,000 shells an hour, and as, allowing for shifts, each diver should work four hours a day, the quantity sent up by two divers in a day would be, respectively, 48,000 or 36,000 shells, which is equivalent to the work of 24 or 18 naked divers, sending up 2,000 shells a day each. The results of the work done by two dressed divers, employed as a experiment at the Tuticorin fishery, for some reaso not explained, fell far short of the estimate, and com pared very unfavourably with the work done by th skilled native divers without helmets. A great draw back and danger to the pearl fishery is the constan risk of cholera. The prospects of a pearl fisher when success seems certain, may be abruptly ruine by accidents from sharks, of which the divers have superstitious, but not altogether unreasonable, drea Tennent says :—“ The only precaution to which th Ceylon diver devotedly resorts to is the myst ceremony of the shark charmer, whose power believed to be hereditary ; nor is it supposed that th value of his incantations is at all dependent upon th religious faith professed by the operator, for th present head of the family happens to be a Roma Catholic. At the time of our visit, this mysteriou functionary was ill, and unable to attend, but he sen an accredited substitute, who assured me tha although he was himself ignorant of the grand an mystic secret, the fact of his presence, as the representative of the higher authority, would be recognise and respected by the sharks. At the Tuticorn fisher in 1890 a scare was produced by a diver being bitte by a shark, but the scare subsided as soon as a “ wis woman” was employed by the divers. Perfectio in pearls consists in shape and lustre, viz., sphericit and a silvery brightness, free from any discolouratio and, according as the pearls possess these essentials the valuers assign their appropriate class, namel *ani*, perfect in spherity and lustre ; *anatari*, followe or companions, failing somewhat in sphericity an lustre ; *masanku*, imperfect, failing in both points especially in brilliancy of colour ; *kallipu*, failing sti more in both points ; *kural*, a double pearl, sometimes perfect ; *pisal*, misshapen, clustered ; *madanku* folded or bent pearls ; *vadivu*, beauty, of several size and classes ; *tul*, small pearls. The pearls havin been sized and classed, each class is weighed an recorded in *kalanchu* and *manchadi*. The *kalanch* is a brass weight, equal, it is said, to 67 grains troy the *manchadi* is a small red berry. Each berry, whe full sized, is of nearly, or exactly, the same weight They are reckoned at 20 to the *kalanchu*. Th weights being ascertained, the valuation is then fixe to each pearl class, or set of pearls, according to th respective sizes and classes ; the inferior qualitie solely according to weight in *kalanchu* and *manchad* The superior, *ani*, *anatari*, and *vadivu*, are not value only by weight, but as so much per *chevu* of thei weight, the *chevu* being the native or pearl valuers method of assigning the proper value by weight to valuable article of small weight, form and colou being also considered. The pearl shell fisheries o the Merguian Archipelago, in the Government o Burma, comprise 11,000 square miles. The gathering of pearl shells is the chief industry, though, o course, pearls are also found. The banks are rente from the Government, and rights to fish sublet on royalty.

FOREIGN TRADE.

The Chemist and Druggist contains some calculations from a recently issued Blue-book of statistical Tables on British trade and production from 1854 to 1894, compared with that of foreign nations. The book contains about ninety pages, full of figures. The following Table is the result of certain calculations made on the basis of the figures in the Blue-book. The quinquennial periods 1875–79 and 1890-1894 are the furthest distant ones which admit of comparison, inasmuch as it is only since 1875 that trade statistics have been kept in Great Britain, the United States, Germany, and France upon a sufficiently similar basis. The relative population of each country has been taken into account, for it is obvious if, to take a suppositious case, the foreign trade of both France and Germany had increased 50 per cent. in the course of twenty years, while the population of Germany had grown by 10 per cent., and that of France had remained stationary, the relative commercial gain of France would have been greater than that of Germany.

IMPORTS.

	United Kingdom.	United States.	France.	Germany.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Average value of imports per head of population, lustrum 1875-79	11 3 5	2 2 5	4 6 7	4 6 1
Ditto, 1890-94 ...	10 19 7	2 11 11	4 8 0	4 2 2
For every £100 of goods imported in 1875-79 the country imported per inhabitant in 1890-94	98·3	122·4	101·6	95·4
Per-centage of increase or decrease	-1·7	+ 22·4	+ 1·6	-4·6

EXPORTS.

	United Kingdom.	United States.	France.	Germany.
	£ s. d	£ s. d.	£ s. d.	£ s. d.
Average value of exports per head of population lustrum 1876-79..	6 0 0	2 16 3	3 14 11	3 3 0
Ditto, 1890-94	6 2 11	2 19 0	3 11 4	3 2 9
For every £100 of goods exported per inhabitant in 1875-79 the country exported in 1890-94	102·4	104·9	95·2	99·6
Per-centage of increase or decrease...............	+ 2·4	+ 4·9	— 4·8	— 0·4

Taking into account the great fall in the price of stable commodities during the past twenty years, the increased output and spending-power of the United States are remarkable. The United Kingdom, it will be seen, has made fair progress. The loss in exports of France is probably due largely to her rigid protectionism, and Germany, per head of population, actually both imports and exports a smaller money's worth of goods than she did in 1875-79.

DISCHARGING AND STORING GRAIN.

Mr. William G. Wales read a paper on "Discharging and Storing Grain," before the Society of Engineers, on the 5th inst., in which he drew attention to the certain though irregular diminution of home-grown wheat and cereals in the United Kingdom, and also to the steadily increasing dependance of the English nation upon external sources of supply. Reviewing the last 25 years he pointed out that the import of wheat alone had increased by 152 per cent., whilst the quantity of home-grown wheat had diminished by 45 per cent., a diminution which shows no sign of abatement. Twenty-five years ago, the import of wheat and flour reckoned as wheat was (taking the average of the last five years at that period) 8,727,541 quarters per annum, whilst the import of wheat in 1895 was an average of 22,044,413 quarters. Twenty-five years ago the home produce of wheat was (taking the average of the last five years at that period) 13,245,194 quarters, whilst the average of the last five years, to-day, is only 7,201,250 quarters. These facts he considered of national importance, and recommended their study, not only from an economic, but also from a political point of view, as not only affecting the agricultural community, but also all the engineering trades to a greater or less degree. He stated that the adoption of grain-discharging machinery had not been very great considering the growth of the imported grain trade during the last quarter of a century, but referred to London and Liverpool as being the two great grain centres where the most modern improvements in this class of machinery were to be seen.

Reviewing the various systems of discharging grain, the author first mentioned that carried out by means of a crane and a Priestman bucket or tub, and explained that this system is often used in England on account of the cranes being able to discharge grain in bags, or ordinary merchandise as well as grain in bulk. He next discussed the various kinds of grain elevators, pointing out that their duty is to dredge the grain from the hold of the ship, and to raise it some twenty feet above the quay. These are roughly divided into floating, fixed, and portable elevators. A self-contained floating elevator was fully described, with all the movements of the elevator leg, showing its great adaptability to circumstances in discharging grain either into barges or on to a quay. The use of a conveyor-band for carrying the grain from the elevator into a warehouse was next referred to. Fixed elevators, which are generally mounted on derrick arms, have been made in this country large enough to discharge grain at the rate of 100 tons per hour, but they are more often only used for discharging grain in barges.

Portable elevators were next discussed. The first type referred to was that designed to be carried from ship to ship, and lowered into the hold. The elevator buckets are driven by a chain from a small engine placed on deck, steam being supplied from a boiler on a barge lying alongside the vessel which is being discharged. The author then made a few remarks on raising grain by means of compressed air and by suction. Apart from the first cost of these systems, their advantages were shown to be great, as all trimming of the grain in the hold of the ship (an expensive item in all other systems) is dispensed with, only one man being required to manipulate the nozzle of the grain pipe, and further, the pipe occupies so little of the hatchway that the discharge of other cargo may be effected through it simultaneously.

GLASS SUBSTITUTES IN GERMANY.

There are several substitutes for glass in use in Germany, the chief among them being tectorium, *fensterpappe*, and *hornglas*. Tectorium is a sheet of tough, insoluble gum—said to be bichromated gelatin—about one-sixteenth of an inch in thickness, overlying on both sides a web or network of galvanised iron or steel wire, the meshes of which are generally about one-eighth of an inch square. The United States Consul-General at Frankfort says that both surfaces of the tectorium in ordinary use are apparently covered with a varnish of boiled linseed oil, and it feels and smells similar to the oiled silk that is used in surgery and for sweat bands in summer hats. It is lighter than glass of equal thickness, is tough, pliant, and practically indestructible by exposure to rain, wind, hail, or any shock or blow which does not pierce or break the wire web by a violent thrust. It may be bent in any desired form and fastened in position by crimping, nailing, or with putty like ordinary glass, and when punctured, it may be easily repaired. Its translucence is about the same as that of opal glass; its colour a greenish amber yellow, which fades gradually to white from exposure to the sun, so that while arresting the direct rays of sunshine, it transmits a soft, modulated light, which is said to be well adapted to hothouses and conservatories. It is a poor conductor of heat and cold, and thus preserves a more equable temperature than glass in rooms containing growing plants. Its surface is well adapted for painting in oil colours, and it is used for illuminated windows, signs, and transparencies, in which strength, lightness, and immunity from breakage are essential, especially in arched, curved, or irregular surfaces. The only objections that c be urged against tectorium are that it is more less inflammable, and that in very warm weather t outside surface is sometimes softened until dust w adhere to it, but this may be removed by wiping washing, a service that is usually performed by t rain in exposed situations. Tectorium is an Engli invention, and Consul-General Mason says that far as can be ascertained, it is not patented Germany. It is claimed for it that it has effect an important economy through its immunity fro breakage, which, in case of large roofs of glass, a so frequent and so expensive to repair. For ordina hotbeds and forcing houses, such as are used by mo florists and market gardeners, the Germans ha another and cheaper substitute for glass in the s called *fensterpappe*, which is a tough, strong mani paper, that may be stretched on large sashes frames and saturated by painting the exposed surfa with boiled linseed oil until it becomes transluce and impervious to water. The paper costs wholesa in Germany about 19s. 10d. per roll 100 metres length by one metre in width, equal to 1,220 squa feet in each roll. There is no difficulty or secr about its preparation or use. Light wooden fram about 40 inches in width, and of any desired lengt are provided, and covered with the paper, which fastened by nailing at the edges, and then painte with ordinary boiled linseed oil, until the paper is saturated that the last coat of oil forms a smooth glistening surface, like varnish. As soon as dry, th frame is ready for use. It admits sufficient light fo growing plants, does not require to be shaded in ho sunshine, is light, durable, secure against breakag by hail or ordinary accident, and, taking everythin into account, is said to be about one hundred time cheaper than glass. It is largely used by florists an market gardeners in the district of Frankfort, an their general verdict is strongly in its favour, althoug for handsome conservatories, skylights, &c., it possesse less durability, and none of the neatness and eleganc of tectorium. Finally, there is a new product, calle *hornglas*, which has been recently patented an placed on the German market. *Hornglas* resemble tectorium in appearance, with the difference that it i thinner, and consequently lighter in weight, and th insoluble gelatin with which the wire gauze is covere is whiter, and more nearly transparent than tectorium although it may be coloured red, green, blue, or an other tint that may be desired for special purposes It is manufactured in two qualities, one being o heavier wire and with larger meshes than the other It is cut into lengths of about 23 feet by 47 inches i width, and is sold wholesale for about 5s. 4d. pe square metre, or rather more than 5d. per squar foot. The special advantage claimed for *hornglas* i that it does not soften under sun heat, and is therefore adapted to use in any climate without the dange of becoming so soft and adhesive as to retain dust and dirt. Its uses and general characteristics are simila to those of tectorium.

OIL AND OZOKERITE DEPOSITS IN RUSSIA.

From time immemorial the island of Cheleken has een famous for its oil and ozokerite deposits. This land is situated in the south-eastern part of the aspian Sea, being separated from the main land by narrow channel, and having an area of about 700 quare miles. The interior of the island is an unnhabitable desert, only along the shore there a few solated settlements of semi-barbarous Turcomans vho have probably been forced to emigrate to this lesolate spot from the plains of Central Asia. According to a recent German report, the oil is orced to the surface by numerous springs of hot ulphur water (102° Fahr.), and accumulates in wells lug by the Turcomans. Long before European prospectors set foot upon the island, the natives were ngaged in the production of oil and ozokerite. The ozokerite was separated from the rock by melting, and sold in the market of Baku. The oil was kimmed off the surface of the water, placed in eather bags, and taken in skiffs to Asterabad, in Persia. This mode of transport was very dangerous, for the Caspian Sea is rather a treacherous sheet of water, and many a Turcoman engaged in this business never came back again. It is estimated that the quantity of oil produced by the Turcomans during the sixties and seventies amounted to 100,000 pouds, or about 12,000 barrels. In 1876, the first attempt in the direction of a rational exploitation was made by Palankowski, a well-known operator of Baku. The attempt, however, did not result successfully, because the upper sands were almost exhausted by the diggings of the Turcomans. The operations commenced by Nobel Brothers, in 1881, were also stopped after a short time, partly because of lack of labour (as the Turcomans refused to work), partly on account of the intention at that time to concentrate the production and manufacture of petroleum on the Apsheron peninsula (Baku). This field was then forgotten, until quite recently the attention of the prospector has been called again to the island, especially by the authorities of the Trans-Caspian territory, who were looking for a cheap liquid fuel for the Trans-Caspian Railway, and caused the resumption of operations on the island, which were accompanied by favourable results. The firm of Nobel Brothers has now resumed digging operations. Analytical tests made in the laboratory of the Technical Committee of Baku have shown that the crude oil of Cheleken Island possesses very peculiar properties. It is of thick consistency at 9° Centigrade, like salve, and becomes solid at a little below 0° C. Its water content is hard to eliminate, and this circumstance proves a serious obstacle in the distillation. Its specific gravity at 15° C., is 0·868, the flashing point 51·5° C. The residue possesses, at ordinary temperature, 22·5 C., the consistency of salve or jelly, a specific gravity of 0·900, and can be worked up directly to vaseline. Another characteristic of this oil is its high content of paraffine, it amounting to 5·5 per cent., which, after being refined, furnished about 3 per cent. of white amorphous paraffine wax. This shows that the crude oil forms a sediment even at not very low temperature. From a sample of crude oil two kinds of illuminating oil were produced, the first kind possessing all the properties of American illuminating oil. It gave a very bright flame at the beginning of the burning process, but the brightness declined greatly towards the conclusion of it. The second kind did not burn so well as the first. By mixing both kinds, a third one was produced, possessing 0·800 specific gravity with the flashing point at 35° C., which burned very satisfactorily. It is stated that the illuminating oil of Cheleken differs from the American article only in its higher flashing point.

THE SPANISH SILK INDUSTRY.

M. Pellegrin, French Consul at Valencia, says that the east and south-east of Spain are, properly speaking, the only parts of the peninsula where the silk cultivation and industry have attained anything approaching a high degree of development. The yield of cocoons in 1895 amounted to 1,200,000 kilogrammes, as compared with 1,100,000 kilogrammes in 1894. The cultivation of silk and its derivatives are contemporaneous with the domination of the Arabs, who introduced it from Asia Minor. Favoured by an extremely favourable climate, this description of production soon began to constitute the chief wealth of the provinces of Valencia, Castellon, and Teruel. The transformation of the cocoon into silk remained for a long time, in a certain sense, a home industry, as the breeder of the worms himself attended to it. Using for this purpose the most primitive of apparatus, the result was defective. The initiative of modernising the silk-spinning industry in Spain is due to a Frenchman, a native of Forey, M. J. Louis Dupuy de Lome. In 1835 M. Dupuy de Lome established at Valencia the first steam-spinning machinery, and the product was highly appreciated on the Lyons market. It was not long before his example was followed by other French and Spanish manufacturers, and about 1860 there were erected 22 steam spinneries at Valencia, two in the province of Teruel, and one in the province of Castellon. These 25 establishments produced annually about 150,000 kilogrammes of silk, which were exported to France, and entirely absorbed by the French weaving establishments. During the same period, the peasants spun about 50,000 kilogrammes annually, according to the Arabian methods. Such was the position about the year 1860, when the disease of the silkworms which had devastated the French worms, made its appearance in Spain, and the production of cocoons rapidly fell off, and to add to the misfortunes, while in France and Italy scientists studied the scourge and devoted themselves to the consideration of the means of checking it, Valencian sericulturists contented themselves with plucking up their mulberry trees. The silk weaving industry is a very ancient one, but it has remained stationary in Spain, very few improvements having been effected in it. Moreover, it supports itself with difficulty in spite of the very heavy Customs duties with which foreign silk tissues are burdened on their importation into the country. The plant is defective, and labour is relatively dear in the interior of Valencia, where from 1,000 to 2,000 looms are at work. A certain number of these are grouped in factories, and these factories, generally situated in the outskirts of the town, are devoted almost exclusively to the manufacture of foulards, and in turning out damasks, surahs, velvets, satins, &c., but all these articles have only a moderate value, for two reasons: one being that the raw material used is composed almost exclusively of Asiatic silk of low price, and the working leaves much to be desired. In the provinces of Teruel and Castellon, silk weaving remains in a very rudimentary condition, and the only articles produced appear to be bolting cloths. In conclusion, M. Pellegrin says, that the textile industry in Valencia is in a very precarious condition, and no efforts appear to be made in order to improve it, while capitalists seem to shun it. In all probability it will be many years before the silk weavers will succeed in turning out high class goods, as they prefer rather to devote themselves to the cheaper classes of ordinary wearing apparel, the consequence of this being that the province must remain dependent upon Lyons and St. Etienne for rich silk stuffs, ribbons, laces, and passementerie. There is no doubt that a very valuable market for French silks would be established in Spain if only commercial arrangements could be concluded, whereby some reduction would be made in the present exorbitant and almost prohibitive Customs duties with which French silks are now burdened on their importation into that country.

Obituary.

William Morris.—The death of Mr. William Morris, at Kelmscott-house, Hammersmith, on the morning of Saturday, 3rd inst., robs the Society of Arts of an active member of the Applied Art Section, who on several occasions gave the Society the benefit of his ripe judgment. On January 26th, 1892, he read before the Applied Art Section a paper on "The Woodcuts of Gothic Books," which, fully illustrated, was published in the *Journal* (vol. xl., p. 147). For this paper he received the Society's silver medal. It is not necessary here to recite the particulars of Mr. Morris's busy life, which was so ful of great results in literature and art, as these have been widely dealt with in the daily press. His main work in life was his great attempt to bring art into the daily life of the people. This is seen in the house, more particularly in his wall-papers, and in the church in his stained glass. Those who compare the glass of to-day in our cathedrals and churches with that of some thirty years back know how much is due to the exertions of William Morris. Not content with his fame as a poet, Morris proceeded to revolutionise the domestic arts; and not content with improving the furniture of the house, he proceeded to show what improvements in printing might be made by a return to hand work. His knowledge of the history of early printing was considerable, and he was most enthusiastic in the collection of English illuminated manuscripts. Some of these valuable MSS. were shown at the exhibition of early English paintings at the Society of Antiquaries, held in the present summer.

General Notes.

Fruit and Vegetable Drying.—The last number of the *Journal of the Royal Agricultural Society* (September 30) contains a report by Dr. J. A. Voelcker on "Fruit and Vegetable Drying at Leicester."

Munich Exhibition of Machinery.—An International Exhibition of Motor Machinery, &c., under the patronage of the Prince Regent of Bavaria, has been arranged to be open at Munich from the 11th June to the 10th October, 1898.

Increasing the Resistance to Fire of Wrought Iron Pillars.—The following are the general conclusions arrived at by a commission appointed by the Hamburg Senate to examine and report upon the resistance to fire offered by wrought iron pillars used in construction. They withstand fire very imperfectly, their stability being quite destroyed at a temperature of about 600° Cent., and the advantage of filling them with concrete is so slight as to be scarcely worthy of consideration. The case is, however, far different with outer coatings of refractory or non-conducting materials, which have proved capable of protecting the metal from a dangerously high temperature during a certain space of time, and, consequently, of affording effective protection against fire. The substances which appear to have exerted the best effect are the cork composition of Herren T. Ganzweig und Hartmann, and xylotile encased in sheet iron, which substances give out inflammable gases for two hours and a half, leaving a carbonaceous residue that is not destroyed by the stream from the fire hose. A pillar thus coated only gives way after being exposed to the fire for four hours, while 17 minutes suffice to destroy it if uncoated when similarly heated. Next to the above-named substances comes the Monier concrete, laid on in a coat of 40 mm. ($1\frac{1}{2}$ inch) thickness, which preserves iron for nearly two hours and a half, while plaster of Paris and asbestos cement only gave poor results.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CERTAIN METALS AND THEIR COMPOUNDS USED IN BUILDING, AND THE CHANGES PRODUCED ON THEM BY AIR, MOISTURE, AND NOXIOUS GASES, &c.

By Prof. John M. Thomson, F.C.S., F.I.C.

Lecture I.—Delivered February 17, 1896.

The various courses of lectures given before this Society deal, as a rule, with questions relating more particularly to novelties in mechanical inventions, or to descriptions by some one specially skilled in the matter of new processes relating to the technical development of various branches of the industrial arts. Such is natural from the very name and nature of the foundation of the Society. It has, however, also been the custom, although it may be thought by some to be straying somewhat out of the usual lines, from time to time to bring before the members general questions, dealing more particularly with the principles either physical or chemical which underlie such practical questions, and on which their successful development depends.

When I was requested to give a short course of lectures to the Society, not being one identified with purely technical work, I thought it might be of interest to those members of the Society who have to deal more especially with the practical questions relating to building and structural operations, to have laid before them some of the chemical questions relating to the materials they employ, and the changes which those materials undergo through the action of time, or exposure to vitiating agents.

Lectures of such a nature in regard to the composition and properties of stone materials, mortars, cements, &c., have already been given to the Society, and I will, therefore, confine myself in the present course to the similar consideration of some of the more important metals and their compounds which are used in such structural operations.

In the time at our disposal it would be impossible to discuss the properties of all the metals and alloys employed, and we must, therefore, be content to make some selection. I propose, therefore, to limit myself to the treatment of the following metals, with some of of their more important compounds, as representing those chiefly used for purely structural and not for decorative work:—

Aluminium,
Copper,
Iron,
Lead,
Tin,
Zinc.

The limit of time will also compel us to keep within the chemical questions involved; and it is therefore my intention to omit any detailed reference to mechanical questions, or metallurgical processes, as being out of our especial province.

The course of lectures will, therefore, deal chiefly with questions relating to the chemical properties of the metals in general use, and the changes which are produced on these metals by union with each other or with other substances.

Before, however, proceeding to purely chemical questions, it would be well to look for a moment at certain physical properties belonging to metals, the study of which may assist us in more fully understanding the bearing of some of the chemical relations which are to be dealt with later in the course.

These properties may, for convenience, be grouped under the following heads:—Expansion under the Effects of Heat; Conductibility to Heat and Electricity; Fusibility; Vaporisation; Malleability; Brittleness; Ductility; Tenacity; Elasticity. The last five may be considered as properties of greater importance in relation to the mechanical strength of metals for structural operations.

The facility with which metals expand by heat is well known to all and can be easily demonstrated to you both as to linear and cubical expansion by the experiments which I have on the table. (Experiment 1, 2, *see* p. 868.) You will readily understand the bearing of this on the expansion of long metal beams now used so much in large building operations. On looking at the Table of physical constants of metals given below, a close connection is to be observed between the conduction of heat by metals and their conductivity for electricity; the metals silver and copper showing this in a very marked manner. The slight difference in the conductivity of different metals for electricity may readily be seen by passing a moderate current from a battery through a wire made up of pieces of silver and platinum. The lesser conductivity of the platinum producing resistance which causes the links of platinum wire to glow, while the silver links remain perfectly dull. (Experiment 3)

When the application of heat is increased we find a marked difference among the various metals in their power to resist such an increas and consequently great differences in the fusing or liquefying points. Such commo metals as iron, copper, and manganese do n yield readily to heat, whereas tin, lead, an bismuth fuse at comparatively low temperatures. Of the rarer metals platinum and iridiu are perhaps the most infusible, whereas silv may be melted with considerable readines The comparative fusibility and infusibility metals can be shown by directing this Bunse flame on these suspended sheets of platinu and tin, when you see the latter shrivel up, once dropping down in fused globules—whil the platinum, although incandescent, remain infusible in the flame.

Although capable of undergoing fusion th common metals resist ordinary temperature without change and therefore occupy unde ordinary conditions the solid state, with the exception of one, mercury, which remains liqui till the temperature reaches —40° and the rar metal, gallium, which melts at 30° C., becoming liquid by the heat of the hand. O the application of greater heat many of suc easily fusible metals volatilise, being converte into vapour and recondensing on cooled su faces. Mercury, zinc, and cadmium are instances of common metals which can be converted into vapour at fairly moderate temperatures.

When metals are heated, or when the are in the liquid condition, certain amon them possess the property of absorbing, more correctly occluding, large quantities various gases. Thus hydrogen gas will pas through sheets of platinum and iron whe kept at a red heat, and silver in the molte condition absorbs many volumes of oxyge gas, retaining this for some time during th process of cooling and suddenly dischargin excess of the gas when the molten mass is o the point of solidifying. This constitutes th phenomenon known as the spitting of metal Among rare metals palladium shows th greatest power in thus absorbing hydroge either when heated, or when the metal is mad the negative pole in a galvanic circuit, bein capable of occluding, under certain circum stances, nearly 900 volumes of that ga (Experiment 4.)

There is great probability that definite unio may take place between the metal and the ga during this occlusion, as the resulting substance shows certain special and definite properties. The absorption by palladium 600 times its volume of hydrogen approx mately corresponds with the formula Pd_2H. Such a compound is believed to be formed, as any excess of gas over and above this quantity is more easily given off than the remainder on heating the metal.

This occlusion of gases by metals is of especial importance in certain metallurgical processes, notably in the Bessemerising of iron, where in blowing air through the molten metal the oxygen becomes retained and intimately associated with the iron.

Of the physical properties, which relate more specially to mechanical questions, we have those of malleability as contrasted with brittleness, and durability and elasticity. Malleability is the property of extending in all directions without breaking, whereas brittleness, is exactly the reverse, the sudden destruction of cohesion. The metals, lead and antimony, may be taken as showing markedly the difference in these two properties; lead may be hammered or pressed into various shapes without injury, whereas a sudden blow at once breaks up a lump of antimony. Metals show great differences in regard to malleability, more especially at different temperatures, some being malleable only when heated, and others malleable at lower temperatures, losing this property to a certain extent when heated.

Similar differences are to be seen in the ductility of metals, this property generally decreasing as the temperature rises. Malleable metals are as a rule also ductile, but the two properties do not follow the same order with the different metals. The difference in the ductility and non-ductility of metals may be easily illustrated by exercising an equal strain on copper and lead wires, when the latter will break long before the former.

One of the most interesting properties possessed by metals is that of elasticity, or the power of the substance to resume its original form after the removal of any force which has externally produced a change in that form. The determination therefore of the "limit of elasticity," and the permanent change, if any, produced on metals by the exercise of force becomes a highly important question for the mechanical engineer. As will readily be understood, the presence of foreign substances in the various metals changes considerably their elasticity, but up to the present time such changes have been only mechanically measured, and we have little information as to any relation between the chemical composition and change in elasticity. The difference in the elasticity of different substances may readily be seen by allowing balls of each to fall through equal heights upon flat plates of similar substances, and noting the different heights to which the balls will rebound. (Experiment 5.)

Table of Physical Constants for some of the more Important Metals mentioned in the Lectures.

	Melting Point.	Specific Gravity.	Specific Heat.	Conductivity for Heat.	Conductivity for Electricity.
	°C.			Ag. = 100	Hg. at 0° = 1.
Aluminium.	625	2·56	0·2143	31·33	31·726
Bismuth ...	268	9·8	0·0310	1·8	0·800
Copper	1050	8·91	0·0952	73·6	55·860
Gold	1045	19·26	0·0324	53·2	43·840
Iron	1600 (?)	7·84	0·1138	11·9	8·340
Lead	325	11·33	0·0314	8·5	4·818
Manganese.	1900 (?)	8·00	0·1200	—	—
Mercury ...	−39	13·59	0·0320	—	1·000
Nickel	1600 (?)	8·80	0·1086	—	7·347
Platinum ...	1775	21·5	0·0330	8·4	8·257
Silver.........	945	10·57	0·0577	100·0	57·226
Tin	227	7·30	0·0562	15·2	8·237
Zinc	415	7·13	0·0955	28·1	16·920

General Chemical Relations of the Metals.

As we have already seen, the metals, although they show some tendency to unite with hydrogen, and form with that substance several distinct hydrides, such as are seen in the cases of potassium, sodium, palladium and perhaps gold, are little disposed in this union to yield strong chemical compounds. They evince, however, very powerful attraction for oxygen and chlorine, forming with the latter compounds, which dissolve without apparent decomposition in water. The chemical relations of the metals to oxygen have so important a bearing on the general questions regarding the extraction of metals from their compounds, that it may be well for us to examine experimentally some of these reactions before proceeding to the consideration of that latter question.

Metals, as a class, exhibit a disposition to unite directly with oxygen, though few will do this under ordinary conditions. Several of them, namely the metals of the alkalies and alkaline earths have such a powerful attraction for oxygen that they undergo oxidation the moment they come in contact with the air, and have, therefore, to be kept under petroleum or some liquid free from oxygen. In the case of these metals, as illustrated by potassium, the attraction of the metal for oxygen is so strong that on bringing it in contact sufficient heat is generated to ignite the hydrogen given off from the water during the decomposition. (Experiment 6.) Iron and lead also undergo superficial oxidation in the air under ordinary conditions, but this oxidation, as we shall see later, is favoured by the presence of other substances, moisture and carbon dioxide. The so-called noble metals, silver, gold, and platinum, show so little attraction for oxygen that they do not even unite with it directly even at high temperatures.

Zinc shows no tendency to unite with air at ordinary temperatures unless moisture and carbon dioxide be present, but if heated it burns with a beautiful blue flame, uniting with the oxygen in the air and forming zinc oxide. (Experiment 7.) Common iron, like zinc, shows no tendency to undergo oxidation in dry air or oxygen at the ordinary temperature, but when heated to 260° C. it oxidises on the surface, the film of oxide becoming thicker as the temperature rises. The facility with which heated iron unites with oxygen can be readily shown by holding a piece of white hot iron wire in the blast from a powerful bellows; or by introducing a piece of annealed watch-spring tipped with a sulphur match into a jar of oxygen, when it will burn with brilliancy, throwing off the particles of oxide as they are formed during the combustion. The black substance found during this combustion is a mixture of the ferrous (FeO) and ferric (Fe_2O_3) oxides, which together constitute ordinary rust. These compounds of zinc and iron with oxygen form a group of substances termed bases, which are in some cases insoluble in water, but which are capable of neutralising partially or entirely acid substances and destroying their corrosive properties. This disposition of metals to form with oxygen such classes of substances is so general that it may be taken as one of the distinguishing features of a metal.

Most of the bases formed in this manner by union with oxygen, although generally insoluble in water, are capable of combining with it, forming hydrates, as may be seen in the slaking of quick lime. On raising the hydrate of lime to a red-heat the water may be removed from it and we obtain again the quick or burnt lime (CaO). We have already seen, however, that certain of the metals are capable of directly decomposing water, as in the case of potassium. In this case on heating the resulting compound we are unable to obtain the water from it; and the compounds in such cases receive the name of hydroxides, indicating a more close relationship between the metal and the elements of water.

As previously mentioned, the other substanc for which metals have a great attraction i chlorine; but here, as in the case of oxygen we find a difference in the circumstances and temperatures at which they will combine with that substance. Powdered metallic antimony sprinkled into a bottle of chlorine, at onc catches fire, antimony forming with the chlorin antimonious chloride ($SbCl_3$), and thin films c Dutch metal, consisting of an alloy of coppe and zinc, burn in the gas with a red light, forming the corresponding copper and zinc chloride ($CuCl_2$ and $ZnCl_2$). (Experiment 8.) Here also as in the combination of metals with oxygen the presence of moisture appears to be necessary for the combination, as sodium may be fused in absolutely dry chlorine, without change while in the ordinary gas brilliant combustion takes place. When the sodium is heated to bright redness in the dry gas, combustion with explosion takes place.

CHEMICAL CHANGES INVOLVED IN THE EXTRACTION OF METALS FROM THEIR COMPOUNDS.

The various changes which take place in the separation of metals from their compounds may be conveniently arranged in the following groups:—

1. The simple fusion of the ore with or without suitable fluxes.

2. By reducing the ore with gases, such as hydrogen or carbon monoxide.

3. By reduction, following the reaction of one compound of the metal with another; as the reaction between sulphide and oxide of lead.

4. By the fusion of a compound of the metal; generally a haloid compound, with another metal.

5. By amalgamating the required metal with mercury and then recovering the mercury.

6. By galvanic action, or by the electric furnace.

7. By wet methods depending on the solution and precipitation of the metals by various reagents.

Without entering at all upon technical

matters relating to metallurgy, it is interesting to examine shortly the chemical changes taking place in these several processes.

In the first, the simple fusion and distillation of the metal from its ore takes place, and is applicable only in the case of the most easily reduced or volatile metals—such as mercury or bismuth.

By the second method the largest number of metals are extracted, the gas employed in practice being carbon monoxide, given off in the combustion of coal in the furnace and from the decomposition of substances mixed with it. The extraction of iron from its ores is the best illustration of this process; and the ordinary action of carbon monoxide on ferric oxide can be easily shown at a comparatively low temperature. (Experiment 9.) The principle of the reaction when dealing with pure oxides may be expressed by the equation:—

$$Fe_3O_4 + 4CO = Fe_3 + 4CO_2.$$

The addition of other substances, when the question of poor ores arises, is a purely metallurgical matter and one which in the present course it would be inexpedient to enlarge upon.

The third general method, where advantage is taken of a reaction between two compounds of the same metal, is an exceedingly interesting one, and embraces a very neat chemical reaction, where the ores are made to reduce themselves. In such ores the sulphur contained in one is made to remove the oxygen in the other, freeing the metal from both ores. (Experiment 10.) Such a reduction is seen in certain lead compounds, and may be expressed by the equation:—

$$2PbO + PbS = 3Pb + SO_2.$$

The fourth method; by the fusion of a compound of the required metal, generally a haloid compound, with one other metal, is one not very commonly employed, but which has been used for the extraction of rarer metals. Magnesium and aluminium are the two metals which illustrate best the application of this method, and considerable quantities of the former of these metals may be obtained on the small scale by the fusion of its chloride with metallic sodium.

A mixture of magnesium chloride, calcium fluoride, sodium chloride, and sodium in the proper quantities, is thrown into a red-hot crucible, which is covered and again exposed to some heat. After the action has ceased, the mass is stirred to promote the aggregation of the globules of metallic magnesium, then poured out and allowed to cool, when the mass may be broken up and these globules collected. They may be further collected into a larger mass by melting under fused chlorides of magnesium and sodium with fluoride of calcium. The chemical reaction is the simple decomposition of the chloride of magnesium by the proportionate quantity of sodium:—

$$MgCl_2 + 2Na = 2NaCl + Mg.$$

It is true that compounds other than haloid compounds of the metals may also undergo reduction by other metals when heated, as is seen in the process for the removal of lead from galena by metallic iron. The reaction on which this process depends is shown by the equation:—

$$PbS + Fe = FeS + Pb.$$

but it is to be remembered that in practice the galena and scrap iron are often assisted by fuel in producing the reduction.

The processes which involve the use of mercury for the separation of the required metals are employed almost entirely for the extraction of gold and silver, and depend not only on the power of the mercury to reduce certain compounds of these metals, but also on its tendency to form, with the metals themselves, those peculiar alloys which receive the special name of *amalgams*. This union of mercury with gold is well known to all, and can be readily demonstrated by shaking some gold leaf in a bottle containing a small quantity of liquid mercury.

In the case of silver, the amalgamation process is adopted, where fuel is scarce, and a reduction of the silver salt by the mercury takes place—

$$AgCl + Hg = HgCl + Ag.$$

Gold may be separated by the same treatment from the impurities remaining with it after its extraction by washing, the mercury being recovered from the amalgam by subsequent distillation. It is worthy of note that the amalgamation of both gold and silver ores is facilitated when a small quantity of sodium is added to the mercury, so forming sodium amalgam. This improvement is apparently due to the sodium amalgam being more electropositive to the gold or silver than mercury by itself.

The electrolytic methods by which metals may be separated from their compounds naturally divide themselves into two classes—(*a*) When the electric current decomposes a compound of the metal in a state of fusion, great heat being developed; and (*b*) when it is deposited upon an electrode, its compound or salt being in a state of solution.

Numerous methods have from time to time been introduced for the production of metals by this method, but it is only since recent advances have been made in the electric furnace that these methods have gone beyond the limit of experimental processes. The method has, however, been employed in the extraction or purification of copper, lead, gold, and aluminium, and in the case of the last-named bids fair to be the best method for its production when water power is available and cheap.

When an electric current is passed through an aqueous solution of an aluminium salt no decomposition yielding the metal takes place, and it is therefore necessary to employ fused salts, generally cryolite, the double fluoride of aluminium and sodium ($Al_2F_6 6NaF$). Alumina (Al_2O_3) itself is added to the fused cryolite from time to time, being dissolved and undergoing decomposition, thus avoiding the expense of a bath of pure haloid salt which would require constant renewal.

The second general method for the electrolytic deposition of metals is found in the electrolysis of their various metallic solutions, and is one of very limited application. All metallic solutions are capable of a certain amount of decomposition by electrolysis, such decomposition varying according to the nature of the metal, strength of current, and nature of the electrodes employed. Even mixtures of metallic salts may deposit when electrolysed the mixed metals in varying proportions, but the circumstances under which these reactions take place are still more complicated than the deposition from solutions of simple metallic salts. In practice, the electrolytic method for obtaining the metal from a solution of one of its salts in some solvent has been mainly used for the purification of copper, which lends itself more particularly to this method of decomposition. (Experiment 11.) The method is, however, employed on the small scale to obtain metals in a high state of purity.

Closely allied to the decomposition of a metallic salt by a current of electricity, is the behaviour of one metal to another when the former is brought in its elementary condition in contact with a salt of the latter. In many cases the simple salt undergoes decomposition, the metal contained in it being deposited on the metal which has been introduced. This action depends upon the decreasing electro-positiveness, as it is called, of one metal to another, and attempts have been made to classify metals according to their power in this direction. Such an action of one metal with the solution of another may be seen in the decomposition of a salt of copper by a slip of iron or zinc, or the decomposition of a mercury salt by a slip of metallic copper. In these cases the copper and the mercury are more electropositive than the metals on which they are deposited.

The consideration of the electrolytic deposition of metals from solutions of their salts naturally brings us to the consideration of what may be termed the wet methods for the isolation of metals.

These methods are very various, and occupy the border line between chemical and purely metallurgical processes. They consist of the solution of the various metals in acid or alkaline solutions; the roasting of the ore so as to form a soluble salt of the required metal; the formation of a soluble body by treatment with various gases; and the precipitation of the metal itself either in a pure form or as some compound which readily undergoes reduction. The fuller consideration, however, of these questions would not be suitable for the present course.

General Questions Relating to Alloys.

The question of the nature and properties of those extremely interesting and important aggregations of metals has been so ably put before the Society by Professor Roberts-Austen that I would refer those specially interested in this question to his lectures, and content myself with very briefly summarising for you, as well as I can, certain general questions relating to these compounds, so that we may the better understand the properties of the special alloys which come under our notice in connection with structural purposes.

The term is applied to any homogeneous mass consisting of two or more metals, and it is difficult in many cases to distinguish the properties of the individual metals, so as to regard the alloy as a mere mixture. On the other hand, the properties of the resulting body in many cases show no special relation to the quantities of the several metals introduced into the alloy, and, therefore, we cannot regard them as true chemical compounds. This difficulty in assigning the formation of alloys to a physical or chemical change is comparable with the difficulty found in the consideration of the condition of a salt when dissolved in water. It has been customary, therefore, to consider alloys as belonging to two classes—(*a*) those which resemble a simple solution where no evidence of the formation of chemical compound is found; and (*b*) as analogous to solutions which contain a compound of the solvent with the dissolved substance; this compound existing as if dissolved in an excess of the solvent. It seems probable that the greater number of known alloys may be placed in this second class.

The application of the *cryoscopic method*, or the *method of determining the molecular weight of a compound by the depression of the freezing point*; or *Raoult's method*; has thrown considerable light on the composition of alloys. Thus, when a small quantity of metal is alloyed with another, the freezing or solidifying point of the preponderating metal is lowered to an extent in accord with Raoult's law, thus indicating that the alloy is only a solidifying solution. On the other hand, experiments where alloys are employed as the electrodes attacked by the acid in a galvanic battery show, that the electromotive force produced under these circumstances is in some cases identical with that produced if the more attackable metal was used alone, and sometimes it is different, showing the influence of the second metal; this difference can be only due to some kind of compound formed in the alloy. When plates of the same metals, closely joined together, are used in this manner, the electromotive force is that which would be produced by the more attackable metal.

The alloys employed in matters connected with structural operations are numerous, and will be examined under the individual metals. The marked difference which exists between metals which form alloys together, and those which refuse to do so, may be shown by melting together lead and tin and lead and zinc. On allowing these several mixtures to cool in suitable vessels, and then examining them, the lead and tin will be thoroughly alloyed, whilst the lead and zinc have separated during the cooling, the lighter metal lying on the top of the other. (Experiment 12.)

One remarkable point which may be mentioned, in dealing with general questions relating to alloys, is the tendency to lower the fusing point of the alloy when it contains certain metals. Thus, an alloy containing two parts bismuth, one part lead, and one part tin fuses below the temperature of boiling water (Experiment 12), although tin, the most fusible of all the three, requires, when by itself, a temperature of 227° C. for its fusion.

Although alloys are industrially made by mixing the constituent metals when molten, they have also been prepared by strongly compressing mixtures of the powdered metals at the ordinary temperature, and by the electrolysis of mixed solutions of the required metals.

General Questions Relating to the Action of Acids on Metals.

Before passing to the consideration of the action of acid substances on the common metals under the ordinary circumstances of exposure to them as vapours in a more or less diluted condition in the atmosphere, there are one or two points of scientific interest connected with these actions to which I would direct your attention, as they underlie to some extent the actions which will have to be considered later in connection with the individual metals.

The action of acids on metals is very various, depending on the nature of the metal and acid, the strength of the acid, and the temperature at which the reaction may be carried out. As an instance of this I would draw your attention briefly to the action of the three acids, hydrochloric, sulphuric, and nitric severally, on the metals, iron, zinc, copper, tin, and aluminium. (Experiment 13.)

The metals zinc and iron furnish us with examples of the ordinary action of a metal on an acid when in the dilute condition, where both decompose the acid in the cold forming a salt of the metal, and evolving hydrogen according to the expression :—

$$M'' + 2HCl = M''Cl_2 + H_2$$

or

$$M'' + H_2SO_4 = M''SO_4 + H_2$$

When M″ denotes one of the already named metals.

It has already been mentioned that perfectly dry sodium is incapable of combining with perfectly dry chlorine, and we must, therefore remember, that in cases of decomposition of the acid by the metal, the third substance water, supplied to dilute the acid may be a most important factor in producing the decomposition. It is impossible here, however, to enter fully on this purely theoretical question.

Secondary changes may take place in the case where the metal iron dissolves in acids, but these will be alluded to later on.

Many metals show no such tendency to decompose acids with the ease evinced in the cases of iron and zinc. Thus mercury and copper remain, in dilute and in strong hydrochloric and sulphuric acid without a reaction taking place until the mixture is warmed, illustrating to us a second class of decompositions which may take place (Experiment 14) thus :—

$$M'' + 2H_2SO_4 = M''SO_4 + 2H_2O + SO_2.$$

The result, so far as the formation of the salt is concerned, is the same as in the first reaction, but from the decomposition of the heated acid which takes place in this case, there is evidence of some secondary changes. Most probably it occurs in two divisions, in the first the liberated hydrogen and salt being formed, and in the second this hydrogen at the increased temperature reducing the additional proportion of acid, thus—

$$M'' + 2H_2SO_4 = M''SO_4 + H_2SO_4 + H_2$$

and

$$H_2 + H_2SO_4 = 2H_2O + SO_2$$

There are, apparently several reactions which may be accounted for in a similar manner.

The reactions of nitric acid with metals are much more varied than those of hydrochloric and sulphuric acid, probably on account of its being a more volatile acid, and suffering decomposition more readily. In almost all cases with this acid, salts of the metal dissolved are formed; but we have a greater tendency for secondary reactions to occur in the decompositions, producing products of decomposition of the nitric acid. This is very marked in the case of copper, which readily undergoes decomposition, producing a gas (nitric oxide) which, on coming in contact with air or oxygen, yields brown fumes, indicating still further products of decomposition.

$$Cu + 8\,HNO_3 \quad 3Cu(NO_3)_2 + 4H_2O + \overset{\text{Nitric oxide.}}{2(NO)}.$$

and

$$NO + O = \underset{\text{Nitric peroxide.}}{(NO_2)}.$$

(Experiment 15.) Small quantities of nitric peroxide are also found in the first decomposition. The change is probably one still more complicated than that which we have expressed, as we find that, by changing the strength of the acid, all the reduction products of nitric acid are obtained.

The action of nitric acid of different strengths on metals is very varied, but there is one which should be mentioned, as it shows the possibility of producing from an acid body a substance which has identically opposite chemical properties to the former. When dilute nitric acid acts on zinc, the alkaline substance ammonia is produced, probably through the action of the hydrogen at the moment of its liberation, reducing a portion of the nitric acid, thus:—

$$HNO_3 + 8H = 3H_2O + NH_3.$$

Though all the common metals, except gold, platinum, and aluminium, are oxidised by nitric acid, they are not all dissolved by i Thus, tin forms, with the acid, an insolubl oxide, which itself possesses acid propertie (meta-stannic acid). The strongest (yellow nitric acid has no action at all on pure tin, bu if the tin is impure or the acid slightly dilutec then violent action takes place, producing th tin compounds and brown fumes of nitric per oxide. (Experiment 16.)

Aluminium shows a marked difference to th other common metals in its non-action wit nitric acid, upon which in the dilute conditio it has no action. On the other hand it readil dissolves in alkaline solutions such as causti potash or soda, yielding hydrogen. Zinc show some resemblance to aluminium in thes decompositions.

The action of metals on nitric acid is extremely interesting from a scientific point o view: those metals with a fuller attraction fo oxygen, not decomposing water or decomposing it only at high temperatures, do not reduce nitric acid to a state lower than NO; those decomposing water at a red-heat yield all the reduction products, and those decomposing water at the ordinary temperature may produce even hydrogen from it.

Experiments Illustrating Lecture I.

1. Different metal bars heated in Ferguson's pyrometer, the increase in length by expansion raising a needle indicator.

2. Brass ball when heated passed through a ring; after heating, the ball may be suspended on the same ring.

3. A current of electricity passed through a wire of silver and platinum links arranged alternately and suspended between two strong copper electrodes.

4. A palladium wire fastened by a cork in the bottom of a vertical glass tube filled with dilute H_2SO_4 is attached at the upper end to a horizontal piece of light wood which acts as an indicator. The wire is attached to the zinc of a Groves battery. A similar platinum wire is attached to the platinum electrode. During the electrolysis the index descends showing that the palladium wire elongates by the absorption of hydrogen.

5. Balls of lead, copper, steel, and marble dropped from the same height on plates of lead, copper, steel, and marble.

6. Pellet of potassium thrown on surface of water in trough.

7. Zinc tassel tipped with sulphur match, burned in stream of oxygen.

8. Films of Dutch metal leaf are placed in a glass flask fitted with cap and stop cock. The flask is exhausted by the air pump, and then opened over a jar of chlorine, immediate combination taking place.

9. Ferric oxide is placed in a hard glass bulb, between two small wash bottles containing lime water. The apparatus having been filled by a current of carbon monoxide, the ferric oxide is heated by a Bunsen burner. The reduction of the oxide is seen by the lime water in the second wash bottle becoming turbid, through the production of carbon dioxide.

10. A mixture of lead sulphide and lead oxide, heated together in a tube by a gas furnace, the sulphur dioxide produced in the decomposition is led through acidified potassium permanganate, which becomes colourless.

11. A solution of copper sulphate in a platinum crucible, decomposed by a weak current. If the crucible is made the negative pole, the copper deposits on the inside, and can be washed, dried, and weighed.

12. Lead and tin, and lead and zinc, cast in ong, hard glass test-tubes before the lecture, and cooled. When broken, the difference between the layer of zinc and lead can be easily seen.

13. Slips of iron, copper, tin, zinc, and aluminium of the same size, in test tubes containing dilute hydrochloric, nitric, and sulphuric acids.

14. Copper turnings and strong sulphuric acid heated in a retort. The sulphur dioxide may be collected and tested with a taper.

15. Copper turnings with nitric acid (sp. gr.: ·120) in retort. The NO produced may be collected in a jar, which, when opened to the ir yields brown fumes of NO_2.

16. Strongest nitric acid poured upon pure in. No action will take place, but on the ddition of water violent decomposition occurs with the production of dense brown fumes.

Miscellaneous.

BELGIAN COMMERCIAL MUSEUM.

The following account of the Belgian Commercial Museum, based upon an article in the "Journal des Tarifs et Traités de Commerce," is taken from the *Board of Trade Journal*. This museum was established at Brussels, under the auspices of the Minister or Foreign Affairs, and came into operation in the ear 1883.

Its chief function is to complete, from a practical nd material point of view, the information collected and published by the Department of Foreign Affairs. The "Recueil Consulaire," made up of reports sent in, by Belgian Consuls, on the economic, industrial, and commercial situation, have for object instruction on the general state of the various countries in which they reside. These reports form but a means of general instruction, though the Belgian Consuls have long known how to embody therein a host of information precise and instructive, even for specialists. Then, the Bureau at Brussels for the translation of Customs tariffs is particularly useful to manufacturers and merchants who send their goods abroad. Information of this kind, if it is well given, not only shows the duties imposed on all classes of goods, but the manner of levying duties, tare, storing and depôt expenses, the way to draw up declarations, Excise dues if they are levied in addition to Customs dues, certificates of origin, &c.; in short, the whole of the charges which are incurred by goods entering another country, and all the conditions regulating the intervention of a foreign country on articles of commerce.

Consular reports and Customs tariffs, however, only furnish an enumeration and a written description of articles of trade. To sell or to buy goods ready for consumption—to manufacture or work up raw materials or semi-manufactured goods from abroad—to prepare and offer for industrial consumption and general trade articles adapted to needs and requirements—this written information, however detailed it may be, is not sufficient. It is necessary for the trader and the manufacturer to see, touch, and even analyse the articles; and thus to complete the information already furnished to commerce by the Government is the object of commercial museums in general and of the Commercial Museum of Brussels in particular.

Naturally, it would be neither possible or necessary to bring before the public interested all articles which form the object of international trade. Some are too costly; some are too bulky; immense spaces would be necessary, and it would no longer be a museum but an exhibition. In the majority of cases business is based on samples.

The Commercial Museum of Brussels is a museum of samples and patterns which have been collected on the spot by Belgian Consuls, who have funds at their disposal for the purpose.

In many cases the Consuls are in the way of obtaining such samples free of cost. It is evident that a foreign buyer will willingly distribute samples. He has thus the hope of finding this same product on better terms, owing to the intervention of the Consul and the Commercial Museum.

The exhibits at Brussels include exotic products, and also merchandise consumed abroad. Many foreign products are purchased for immediate consumption: some also for re-exportation under a new form after a finishing touch has been given by national workmen.

Following the example of Brussels, the Commercial Museum which the French Minister of Commerce wishes to establish in Paris should take in the samples sent to France, as well as models of French goods. French manufacturers can use the former and imitate the latter. But it is not enough to grant credits to Consuls for the purchase and carriage of samples. The condition of the articles, the customary sizes, the cost and nature and mode of packing, the cost of carriage to the interior, shipping charges, &c., are all as necessary to know as the stuff itself. All these details should be added to the sample and made out by the sender. A very long time ago there was a museum of samples in France; this was the permanent Colonial Exhibition; but it never served any purpose, for there was no indication of cost of any kind attached to the samples.

The chief task of the staff of a museum is a good classification of the products, and a quick method of acquainting those interested with all their commercial conditions.

In Brussels, the Commercial Museum publishes a weekly journal, which announces the arrival of new samples, their nature and origin, with a special notice for any new products. A catalogue of all the articles, with an alphabetical index has also been drawn up.

SUGAR INDUSTRY OF QUEENSLAND.

Queensland has a superficial area of 660,000 square miles, and extends from the 11th to the 29th parallel south latitude, and from about 137° to 154° east longitude. Fully one half of the country is within the tropics, and much of the rest is semi-tropical. There is a range of mountains stretching from the New South Wales border north to about the 17th parallel, and varying from 40 to 100 miles from the sea coast. East of this range is the chief rainfall, which is extremely irregular in the whole of Australia, and east of this range also lie the sugar lands, divided into a few widely separated and distinct districts. The principal of these is Mackay, lying chiefly between the 20th and 21st parallel south, and longitude 149° east, and Bundaberg, with its centre on the 25th parallel, and in longitude 152° and 158° east, the former having a mean annual rainfall of 71·51 inches, and the latter of 48·84 inches, usually from January to March. The altitude of the cane fields is usually but a few feet above sea level, and never over 200 feet. On the lower lands, some distance from the coast, there are occasional frosts which do considerable damage to the crops. The rain usually falls in January, February, and March. The United States Consul at Sydney says that, so far, the production of sugar has been confined to cane, the varieties used being chiefly Rappo, or Rose Bamboo, Louzier, Striped Singapore, Striped Gingham, Meera, Elephant, Malabar, Daniel Dupont, Bourbon, Salangore, Cheribon, and some other varieties. The industry was introduced into the colony in 1862 and though at first there were some discouragements by reason of small experience, there has been a uniform increase and improvement in the production. In the year 1880, there were 12,306 acres under sugar-can and the amount of sugar produced was 15,564 tons in 1890, 42,208 acres and 69,000 tons, while in 189 the acreage was 49,839 acres, and the productio 91,711 tons. For the best results there are tw kinds of soils chosen for sugar-cane culture. One purely alluvial, rich bottom lands usually subject overflow, and the other is purely volcanic. T former has the advantage of retaining for a long time its native fertility, while the other is exem from various evils which often follow in the train the Australian rainy season. At Bundaberg the are several thousand acres of luxuriant and beautif fields. As far as the ash and lava covered the lev plain the soil is very fertile, but up to the very edg of this it is as sterile as a desert. This rich volcan land is covered with an almost impenetrable jung called "scrub," while the more ancient surface has thin covering of a worthless wire grass, and stunte shrubs and trees. The scrub land or jungle regarded as the best soil for sugar-cane, though th expense for preparing it for the first crop will averag fully £4 per acre. Even then the land is not cleare The method of preparing for the crop is to fell a the scrubs, trees and undergrowth, and when a fe months of hot, dry weather has had its effect, th field is set on fire and burned. This done, the can is planted at once with hoe or spade, the joints cane being planted much as in the Southern Stat of America, except that they are planted deeper i the soil. The ground thus prepared is called th virgin scrub. The cane thus planted is carefull cultivated with the hoe, which is called "chipping the cane. The planting is done when the ground ready, regardless of the season, though March an September are considered the best time for this work As much as 90 tons of cane per acre have been raise from ground so planted, but the second and thir crops, or ratoons, are a little lighter. Usually th ground is allowed a season's rest, after two or thre successive crops. On most of these lands the roo and stumps decay rapidly, so that after a few crop are raised, the plough is used for preparing an cultivating the soil. In the preparation for the cro after the ground is cleared, the plough is used an the soil is stirred to a depth of 12 to 14 inches. B far the greater portion of the sugar lands, and especially those actually planted in cane, are owned by very small number of persons. Most of the fiel are on large estates, and most of the cane is grow by hired labour, under the supervision of overseers There is a tendency, however, to a new order things, low prices and keen competition sugges improved methods and new economies, and th tendency now is to divorce cane-growing fro sugar-making. The cutting and crushing season i Queensland is from August to December, inclusive The mills are scattered at convenient points throug the district with a view of economising transportation. From the mills there are lines of tramway reaching out into, and through, the plantations an farms to receive the cane from the carts, which bring it direct from the cutters. These lines run as far as six or seven miles out, with various branches, that leave no great distance for the carting of any part of the crop. As the fields are quite level, this tram system effects a great saving in the handling of the product. There are 84 sugar mills in the colony, 22 of which are exclusively crushing mills, while 62 are furnished with machinery and appliances both for crushing and sugar-making, while one — the Milaquin mill at Bundaberg—performs the whole process and turns out a quality of refined sugar equal to the best found in the market. This mill has a capacity of from 8,000 to 10,000 tons per season of six months in the year, and Consul Bell says that it is one of the most perfectly equipped sugar manufactories in the world. Whilst most of the sugar mills are on the plantation, the Milaquin mill is in the city of Bundaberg, and is supplied from crushing mills located in the cane fields, the juice being pumped through pipes from two to seven miles, or carried on railways in tanks, much resembling the oil tanks in use in the United States. Conveying the juice from crushing mills in the cane centres to the factories—near railway or wharf—in pipes is found to be a most satisfactory and economical method. It is stated that sugar is being made at Bundaberg and Mackay more cheaply than at any other point on the globe. Raw sugar has been declining in price for several years, yet in Queensland, every decline in price has been followed by greater expansion and greater economy in production. At present prices sugar can be produced in Queensland at a fair profit. As about five-eighths of the cost of cane, and sugar production also, is labour, the labour question in Queensland, as in other countries, is an important one. This question as it relates to the sugar industry in Queensland, presents some unique features. Owing to a rather common notion that white men could not perform manual labour under the scorching heat of a tropical sun, a custom of using the dark-skinned races for certain classes of work on sugar plantations has of late years received the sanction of law. There are now about 7,500 South Sea Islanders, called Kanakas, engaged in labour in this industry in Queensland. These islanders being employed under the provisions of law, their rights are secured by a scrupulous enforcement of all the regulative provisions. Bringing them to the country is called "recruiting." This is the method—a ship secures a license to go on a "recruiting voyage" to certain specified islands. On the ship there is a Government agent connected with the Melanesian Immigration Bureau, whose duty it is to guard the interests of the blacks, and to see that there is freedom of contract and no imposition. All matters of business must be explained fairly; the nature of the labour, the time, wage, and all essential particulars must be understood by the contracting parties, who sign the articles of agreement in the presence of witnesses. These labourers are engaged for a term of three years, with a stipulation for a return after the expiration of the term at the option of the *employé*. The blacks in Queensland are field hands, and they may, and may not, do certain things. They may "chip" (hoe) cane, fell trees, pick stone, dig stumps, cut or handle the cane, but they cannot cart supplies, plough, harrow, or even cart manure, for these are the tasks of white men. These laws and rigid rules are adopted that the blacks may not be real competitors with the whites, and as the white people will only do the work when they become tenants or owners of small holdings that the blacks now do, and as the blacks are unaccustomed to the use of horses or oxen, a real competition can hardly be said to exist between the two races.

Correspondence.

DAIRY PRODUCE.

On page 851, column 1, of your *Journal* of October 9th, Mr. W. Preece is quoted as saying:—"The directed and instructed intelligence of the Danish farmer, and the introduction of the co-operative system beat the ignorant conservative and self-satisfied English farmer in his own market." I quite agree with this remark, and have no doubt that Mr. Preece would have carried the matter a little further if he could have known the following particulars:—

Seeing that a large quantity of sugar of milk was coming to this country from Switzerland and southern Europe, I sent my son through the districts where it was produced, and he reported to me that the process was as follows: The milk is brought in, and the cream taken off; cheese is made out of the milk, and the residue is then placed in iron pans, and a crystallization soon sets in, which is the sugar of milk; what is left beneath these crystals is given to the hogs. He informed me further that in many instances the whole of this operation took place in sheds or barns, at any rate not in first-class manufactories. Some were large farmers, some small, some produced a good article, and others not so good—at any rate, it all met with a ready sale.

I think that many of your readers will consider that Mr. Preece's suggestion of some education in these subjects is likely to prove of value in agricultural districts.

For many years I have advocated the increase of poultry, and I should be discouraged with the prospects of the farmer, if it were not for the fact that, as civilisation increases in this country, so the educated classes, who work with their brains and their minds, must stop eating beef and mutton, and go on to veal, poultry, and game; therefore, the demand will continue to increase, and a high quality will be sought for.

Spending so many hours every week close to the great refrigerating chambers in Leadenhall Market, I carefully watch what is going on there, and I admit that there is an immense advantage in this cold-air system, because the poultry is collected in Australia, just at the season when the stubbles afford such excellent food to the birds, they are killed, prepared, and sent to England, and arrive in our early spring, when the markets are very scarce of poultry. These birds compete even against the young ducks; and, as to the turkeys, anyone who has not tasted them would not believe what an excellent quality they are; the flesh from the turkey is superior to almost anything we can obtain in this country; and they are size for size at about half the money.

I had hoped that the industry of eggs would have been left to the English farmer; but when the eggs are in their prime in this country, and they arrive in splendid order from France and Belgium, they are collected, and the cases put down into the cold chambers, and as soon as eggs become scarce, those from the cold chambers compete against the "new laid eggs." As cooking advances, so the demand increases for an unquestionable quality of "new laid egg" and for the highest quality of butter, and it is this demand which the English farmer can supply and obtain a remunerative price for. There is nothing new in this statement, because anyone accustomed to visiting the markets in Paris, upon inquiry can understand why such enormously high prices are paid there for quality of food.

It is all very well to tell the farmer to look to education, and that by education he will be able to overcome all his difficulties, but the farmer in this country is very unfortunately placed. We live on an island, although not a large one, yet densely populated, and the changes of temperature and the inclement and uncertain weather are very trying, and frequently destroy every chance of profit when the most careful arrangements have warranted the expectation of a remunerative success.

A bitter complaint that the farmers make, and which they are justified in demanding redress for, is the extortionately high prices charged them on every occasion by the railway companies. They are warranted in demanding redress because railway companies, by a combination with steamship owners, grant exceptionally low prices to foreigners or foreign agents bringing fruit and food from abroad to the large markets in London, Manchester, Liverpool, and elsewhere.

The opposition of the large railway companies is so strong that one of the ways to meet them will be the local tramways, similar to those working so successfully on the Continent. Trucks can be run during the night, and also during the day, from farm to farm, collecting produce and bringing it to a depôt; and as soon as ever these tramways get to work, the competition will be so great between the main lines of railway to get the produce from the tramway companies, that they will knock down their rates at once, so care must be taken by the landed proprietors, and those who work with them, to see that the railways do not monopolise the working of the tramways.

THOMAS CHRISTY.

Obituary.

BARON SIR FERDINAND VON MUELLER, M.D. K.C.M.G., F.R.S.—Baron von Mueller, the eminen Government Botanist of Victoria, who died las week at Melbourne, was an honorary corresponding member of the Society of Arts, having been elected in 1883. He was born at Rostock, in June, 1825 and after studying at Kiel University (where he took the degree of Ph.D.), and devoting his attention to the investigation of the botany of Schleswig and Holstein, he emigrated to Australia in 1847, in the hope of counteracting a tendency to consumption in his constitution. From 1848 to 1852 he travelled over 4,000 miles, mainly for botanical purposes. In the latter year he was appointed Government botanist to the colony of Victoria, and a few years later Director of the Botanic Garden of Melbourne. He was a most voluminous author, and the titles of over a hundred papers by him are given in the Royal Society's catalogue of scientific papers, the first being dated 1852. He was elected a Fellow of the Royal Society in 1861, and obtained one of the Royal medals of that society in 1888, he was made a baron by the King of Würtemburg, in 1871, and in 1879 he became a Knight of the Order of St. Michael and St. George. During his active life he was the means of introducing many useful plants into Australia, and he took a leading part in the introduction of the eucalyptus into Algeria and elsewhere. He was the first to raise the great Victoria Regia water lily, and it is said that his travels in Australia for botanical purposes, on foot and on horseback, covered about 25,000 miles.

General Notes.

THE POPULATION OF JAPAN.—The population of Japan, according to the statistics of 1894, amounted to 41,810,000, showing an increase of 424,000 over the previous year, and an average increase for the past 10 years of 400,000. Should the population continue to increase at the present rate, in less than 100 years it will have reached the figure of 80,000,000. In 1884 the population amounted to 37,868,000; in 1890, 40,473,000; in 1892, 41,089,000; and in 1894, to 41,800,000. Taking the liability of Japan per head of population, on account of the national debt, it is found that she is by no means heavily burdened, the indebtedness amounting to 0·65 yen per head (yen = about 2s. 2d.). In establishing a comparison on this scale with other countries, it is found that Great Britain pays 6 yen per head; France, 12 yen per head; Germany, 4; Russia, 2; Austria, 5; Turkey, 1½; Portugal, 8; and Norway and Sweden 1 yen per head.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CERTAIN METALS AND THEIR COMPOUNDS USED IN BUILDING, AND THE CHANGES PRODUCED ON THEM BY AIR, MOISTURE, AND NOXIOUS GASES, &c.

By Prof. John M. Thomson, F.C.S., F.I.C.

Lecture II.—Delivered February 24.

Special Consideration of the Selected Metals and their Compounds.

Of all the metals employed in structural work, iron may be regarded as the most important, both from its wide distribution in nature and from the comparative ease and cheapness with which it may be obtained.

Iron does not exist to any great extent free in nature, although it is found in the metallic condition in meteorites, associated with nickel and cobalt, and sometimes as metallic globules in certain meteoric rocks. The chief compounds in which it exists, to an extent which render them available for the extraction of the metal, may be summarised in the following Table :—

Red haematite	Ferric oxide...........	Fe_2O_3
Brown haematite	Ferric hydrate.........	$2Fe_2O_3 . 3H_2O$
Magnetic iron ores ...	Ferroso-ferric oxide.	Fe_3O_4
Spathic iron ores	Ferrous carbonate...	$FeCO_3$
Iron pyrites	Ferrous bisulphide. .	FeS_2

The names and compositions here given are those of the ores when in a perfectly pure condition, and it must be remembered that, in almost every case, these ores are found in nature frequently associated with extraneous minerals which exercise considerable influence on the quality of the iron obtained from them. Some of the most important impurities found in British iron ores are given in a Table on p. 874.

From these numbers it will be seen that, in this country, red haematite contains the largest quantity of iron, and may be regarded as the purest ore; brown haematite containing considerable quantities of P_2O_5, and the spathic ore, much manganese.

Iron is of importance both from its physical and from its chemical properties. Being among the least fusible of common metals, iron, in its various manufactured forms, can be used for the construction of apparatus and furnaces to withstand high temperatures, and from its chemical relations to carbon, yields us, when combined with a small quantity of that element *steel*—far harder than iron—and with a larger quantity, *cast-iron*, which undergoes fusion with greater ease.

Ores.	Iron.		Manganese Oxide. MnO.		Phosphorus Pentoxide. P_2O_5.		Pyrites. FeS_2.
	Max.	Min.	Max.	Min.	Max.	Min.	
Red haematite	69·1	47·47	1·13	trace	trace	trace	0·06
Brown haematite	63·04	11·98	1·6	,,	3·17	—	0·03
Magnetic ore	57·01	—	0·14	—	0·10	—	0·07
Spathic ore	49·78	—	12·64	1·93	0·22	—	0·11

The purely metallurgical details connected with the extraction of iron from its ores cannot be dealt with here, and any description must necessarily be confined to a short statement of the general principles on which such an extraction depends.

As we have already seen, when a pure oxide of iron is obtainable, the action of a reducing gas, such as CO, obtained from the combustion of charcoal, is sufficient to reduce the metal:—

$$Fe_3O_4 + 4CO = Fe_3 + 4CO_2.$$

(Experiment 1.) This method of refinement is, however, impossible in ordinary or poorer ores, highly charged, as they are, with silicious and other impurities. These ores, therefore, require fusion with a fuel containing itself a considerable proportion of ash, as well as the addition of limestone, which assists in the formation of fusible silicates or *slag*, this slag carrying away with it a large proportion of the foreign impurities originally existing in the ore. Although much of the impurity leaves the ore during this fusion, the iron still retains amounts of sulphur, phosphorus, silicon, and a proportion of the carbon derived from the fuel.

The final removal of most of these impurities from the crude iron depends on their undergoing oxidation at higher temperatures than the iron itself, and so being removed as oxides. This oxidation is effected by throwing into the melted crude metal either solid Fe_2O_3 (puddling), or by blowing air through the molten mass (Bessemerising). The carbon is thus removed as CO_2; the silicon and phosphorus being converted into SiO_2 and P_2O_5 respectively, are eliminated by conversion into a second quantity of slag. The entire process for the manufacture of iron from the ordinary ores may be summarised under the following headings:—

(*a*) The preliminary roasting or preparation of the ore for smelting; when volatile impurities are removed, and the ore broken up.

(*b*) The reduction of the ore in the blast furnaces with coal and limestone to obtain the crude (pig) iron and to remove impurities by formation of slag.

(*c*) Final oxidation of more closely attached impurities by puddling or Bessemerising.

Of the impurities mentioned, that which bears the most important part in the differentiation of the kinds of iron employed is carbon, and according to the quantities of that body the varieties of the metal may be arranged as *cast-iron*, *steel*, or *wrought iron*. For minute differences between these we must refer to works on metallurgy; it will be sufficient for our present purpose briefly to summarise them.

Wrought-iron, which is soft, malleable, ductile, but still very tenacious, is produced when carbon is entirely absent, or present only in small quantities, in rough numbers generally less than 0·25 per cent.

Steel is formed when the carbon rises to an amount varying between 1 and 2 per cent., giving to the iron greater elasticity and ductility, rendering it more fusible and more capable of receiving different degrees of hardness by tempering.

Cast-iron is that variety which contains much larger quantities of carbon, rendering it hard and brittle, and consequently preventing it from being welded or forged. The per-centage of carbon varies much in the different kinds of iron, and no very strict line of demarcation can be drawn with regard to the percentage of that element in the various varieties of the metal. There are as many as eight grades of cast-iron employed for commercial purposes, varying in shade from dark grey to a peculiar white shade. These varieties differ apparently from the various relationships between the carbon and the iron in the different cases. Iron fused with carbon takes up about 6 per cent., forming a brilliant white substance closely agreeing with the chemical formula, Fe_4C. As the fused mass cools a certain quantity of the carbon is deposited throughout the iron in a crystalline or graphitic form; we have thus the carbon existing in the metal in two forms, the combined and uncombined form. The difference between these is readily seen by dissolving the cast-iron in dilute hydrochloric or sulphuric acid, when the uncombined carbon is left and the small amount of combined carbon goes off as volatile hydrocarbons.

Grey cast-iron is soft and can be turned in a lathe, whilst the white is hard and of a higher sp. gr. = 7·5, the grey being 7·1. The fusing points are also different, the white variety fusing at 1100° C., the grey at 1200° C., but this latter when fused is much more liquid than the other and consequently more applicable for casting. The amounts of carbon in cast-iron vary from a maximum of 4·81 per cent. to a minimum of 1·04 per cent., and the following numbers show generally the differences in the amounts in the three varieties :—

	Grey.	Mottled.	White.
Combined carbon.	0·30	0·75	3·20
Graphitic carbon .	3·70	2·90	—

The following Table shows the diminution of the impurities which is produced by refining or puddling iron, the numbers being given in percentages :—

	Carbon.	Silicon.	Sulphur.	Phosphorus.
Grey pig iron .	2·275	2·720	0·301	0·645
Puddled bar . .	0·296	0·120	0·134	0·139
Pure wire iron.	0·111	0·088	0·094	0·117

The action of acids upon pure iron is somewhat peculiar, it appears to be unattacked by concentrated nitric and sulphuric acids at the ordinary temperature, although it dissolves readily in these acids when dilute. When exposed to strong nitric acid it remains apparently without action on the acid, at least no bubbles of gas are given off from it, and when the iron is removed from the strong and placed in weak acid it remains even then unattacked. Under such conditions it is said to occupy the passive state. It has been assumed that when in this condition it has become coated with a film of the magnetic oxide, Fe_3O_4, a circumstance which will be alluded to later on.

On examining the compounds iron forms with other substances, one of the most interesting facts brought under our notice is the tendency of this metal to form two large classes of compounds, in which the relationship of the iron to the other substance is extremely distinct. The names given to these two classes of iron compounds are ferrous and ferric, the first indicating a lower relation and the second a higher relation to whatever electro-negative element may be united with it: thus, FeO, $FeCl_2$, $FeSO_4$ are ferrous compounds, whilst Fe_2O_3, Fe_2Cl_6, and $Fe_23(SO_4)$ belong to the ferric class. Substances belonging to these two classes of iron compounds can be easily distinguished by their action with certain organic cyanides, notably the yellow prussiate of potash. (Experiment 2.)

Many of the changes which iron compounds undergo on exposure are due to the readiness with which compounds of the ferrous class change by oxidation into those of the ferric, as may be seen in the attempt to prepare and keep ferrous compounds or salts (Experiment 3); most direct or indirect oxidising agents rapidly converting the one into the other. (Experiment 4.)

This conversion is more apparent in the salts of iron than in the metal itself, which will remain unacted on in perfectly dry air, and becomes oxidised and coated with hydrated ferric oxide, $2(Fe_2O_3)$, $3H_2O$, or rust, only in the presence of moisture and carbon dioxide.

Such a change is seen in the general deposition of a red scum along the edges of shallow streams of chalybeate waters, when the oxide of iron is gradually deposited from the clear water on exposure to the air. (Experiment 5.) At present it is supposed that the moisture undergoes decomposition by the iron, ferrous carbonate being formed—

$$Fe + H_2O + CO_2 = FeCO_3 + H_2.$$

This undergoes solution, and, absorbing oxygen from the air, becomes decomposed, the hydrated ferric oxide being deposited—

$$2FeCO_3 + O = Fe_2O_3 + 2CO_2.$$

There is, however, at the present moment, some doubt as to the exact chemical reactions which take place during the rusting of iron. The corrosive action on iron occurs most violently when surfaces are alternately exposed to moisture and to air, and less violently when entirely covered with water. Apparently, cast-iron and steel are more readily acted on than wrought-iron by water containing saline impurities.

The chief methods for preserving iron, apart from mere mechanical covering, depend upon the formation of an insoluble coating on the surface of the metal, or the introduction of some preservative material some little distance into the pores of the metal. Thus iron may be heated to a temperature of about 156° C., and then placed in a bath of pitch and oil, kept at a temperature of 100° C, when it apparently becomes coated, or takes up some of the preservative in its pores.

Other processes, more notably those of Barff and Bower, depend upon the formation of an extremely hard coating of the magnetic, or some other oxide. The metal in the process of Barffing is first heated in a muffle till the proper temperature is reached. A current of superheated steam, at a temperature of about 540° C., is blown into the muffle, causing a film of the magnetic oxide (Fe_3O_4) to form. The thickness of the coating depends, of course, upon the length of time of the exposure in the furnace, varying from six to eighteen hours.

In Bower's process virtually the same result is arrived at, but in a shorter time. The metal is first coated with a film of the ferric oxide (Fe_2O_3), by heating it in a brick kiln in contact with combustible gases, mixed with an amount of air in excess of that required for proper combustion. In a short space of time a red oxide is formed upon the surface, after which the supply of air is turned off, and the combustible gases by themselves change the ferric oxide into the magnetic oxide. This process of alternate oxidation and reduction is carried on till a coating sufficient for the required purpose is obtained.

Other methods of preserving iron, such as galvanising, will be considered under the special metals employed as the covering.

COPPER AND ITS COMPOUNDS AND ALLOYS.

Although iron, from its strength and cheapness, is used whenever possible, there are certain circumstances connected with structural arrangements where lightness of material, accompanied with great strength and tenacity, are required, and it is under such circumstances that the metal copper and some of it alloys are found of peculiar advantage. This metal is also extremely malleable, which permits of its being readily moulded by the hamme and rolled out into thin sheets. Its resistance also, to the action of moist air gives it grea advantage over iron, and the circumstance that it does not decompose mixtures of sulphuric acid and water, enable it to be used in galvanic batteries, &c. Copper can be fused at a much lower temperature than iron, namely, about 1050° C., and, from its own properties, and the ease with which it alloys with certain other metals, becomes exceptionally useful for many purposes.

The action of other metals, when present in pure copper, is very marked in controlling the tensile strength and durability of that metal, and this action apparently depends also to a certain extent, on the presence of oxygen in the metal. Thus, bismuth in pure copper lowers the tensile strength and durability of the metal considerably; and the presence of oxygen in the metal diminishes this property in a marked manner. Antimony and lead have an injurious influence on copper, but not arsenic, and nickel exercises a distinctly hardening effect.

The sources from which copper is generally obtained are copper pyrites ($Cu_2S. Fe_2S_3$); variegated copper ore, or peacock copper (Cu_3FeS_3); copper glance Cu_2S.; red copper ore Cu_2O; and green $\left\{(CuCO_3. Cu(OH)_2\right\}$ and blue $\left\{2(CuCO_3). Cu(OH)_2\right\}$ malachite.

The general methods illustrating the separation of the metal from its ores may be arranged in two classes: (*a*) Dry method and (*b*) wet method; the last stage of the dry method illustrating to us the second general process of roasting ores which was mentioned at the commencement of the lectures. The chemical reactions in the extraction of copper by the dry method appear, at first sight, more complicated than the extraction of iron, as it is divided into three different sections:—(1) The preliminary roasting of the ore to get rid of volatile impurities; (2) the fusion with silica to remove iron as slag, and obtain the copper as sulphide; and (3) the final roasting of mixed sulphide and oxide of copper, when the metal is obtained by self-reduction—

$$Cu_2S + 2CuO = Cu_4 + SO_2.$$

The wet method in the case of copper is generally employed for the extraction of the metal from poor ores, and depends upon the possibility of changing moist copper sulphide into sulphate through oxidation by air, and the decomposition by metallic iron of the solution of the copper sulphate formed,

$$CuSO_4 + Fe = FeSO_4 + Cu;$$

(Experiment 6). The crude copper so obtained is melted, and refined, or the electrolytic method of decomposition may also may be used.

Other chemical methods for dissolving the sulphide from the ore are also employed. (*a*) The ore may be heated with a mixture of ferric chloride and common salt, when the copper sulphide is converted into copper subchloride, this being finally dissolved by the common salt—

$$Cu_2S + Fe_2Cl_6 = 2(FeCl_2) + Cu_2Cl_2 + S.$$

(*b*) The same result is obtained by a double process of simultaneously roasting and chlorinating with common salt in a furnace. The chemical change is the same as in the first case. In both these methods the metal is finally obtained by decomposing the solution of copper chloride by metallic iron.

As was seen in the case of iron, copper shows in its chemical relations with other elements also a tendency to occupy two distinct conditions, forming two classes of compounds, cuprous and cupric.

Some of the most interesting points in connection with the properties of copper compounds are seen in the differences existing in the oxides and in the chlorides of the metal, and the relationships of some of those compounds to water. Cupric oxide, either in its hydrated or anhydrous condition, may be obtained by precipitation from copper salts by alkalies, the composition of the oxide depending on the temperature at which the reaction is carried out. By precipitation in the cold the hydrated oxide is obtained as a beautiful blue substance of the composition $CuO.H_2O$, the water remaining attached to the oxide at that temperature. On the other hand, if the solutions of the copper salt and alkali be heated to boiling, the oxide in its anhydrous condition as CuO, is precipitated as a dense brownish black powder.

When reducing agents are brought in contact with cupric oxide or cupric salts under certain conditions, the lower or cuprous oxide is obtained. Thus it may be formed by fusing together a mixture of CuO and metallic copper in a closed crucible, by boiling a solution of copper sulphate with sodium carbonate and sulphite—

$$2CuSO_4 + 2Na_2Co_3 + Na_2SO_3 =$$
$$Cu_2O + 3Na_2SO_4 + 2CO_2.$$

or by precipitating an alkaline solution of cupric tartrate by glucose. The oxide so obtained is a beautiful red amorphous powder; but it is also found in nature crystallised in regular octohedra. It dissolves in ammonia out of contact with air to an almost colourless solution (Experiment 7); but the moment air is admitted it becomes converted into a brilliant blue solution of the cupric oxide. This blue solution has the power of dissolving paper, cotton, and other varieties of cellulose, the substance being reprecipitated from its solution when poured into acidulated water. (Experiment 8.)

Both the oxides are formed when metallic copper is heated in air, the portion of the scale in contact with the air being CuO; that in contact with the metal Cu_2O.

The relation of colour to the composition of copper salts is of considerable interest and depends chiefly, either on the change just referred to of cuprous into cupric salts, or to the presence or absence of water in these salts. This change of hydration is readily seen when a cupric salt, such as the sulphate, $CuSO_4.5H_2O$, is deprived of a portion of its component water; it loses its colour, becoming a grey coloured powder at 100° C., but at once changes back to the original blue on the addition of water. Cupric chloride also shows a similar change. Strong solutions of this substance are of a deep green colour, but when diluted with water turn to blue, on attaining their full state of hydration. (Experiment 9.) The change from the cuprous to the cupric condition is analogous to that already observed in the compounds of iron, and are produced by similar reagents, viz., direct or indirect oxidising agents. (Experiment 10.)

The green colour which is imparted to copper sheeting when exposed to certain conditions appears to depend greatly on these last-named changes, namely; those of oxidation, on thin films of compounds originally formed on the surface of the metal. The green colour is apparently some compound analogous to copper oxychloride (Brunswick green)

$$CuCl_2.3(CuO)\ 4H_2O,$$

as it may be formed on sheets of copper much in the same manner as that salt is itself made.

The sheets of copper must first of all be thoroughly cleansed from grease, and then rubbed with solution of hydrochloric acid and sal ammoniac. After this has remained upon the surface for some time, it should be further rubbed with a moist paste of bleaching powder (chloride of lime) and then left exposed to the air for some time. (Experiment 13.) Exposure to a good current of air, especially near the sea coast, facilitates the formation of the green coating on copper. If copper oxy-chloride is the substance formed in this coating, it is probably produced according to the following reaction:—

$$Cu_4 + 2HCl + 3H_2O + O_4 =$$
$$\left\{CuCl_2 .\ 3(CuO).\ 4(H_2O)\right\}$$

However produced, and it is not easy to produce it artificially, this coating is easily destroyed, being extremely susceptible to the action of vitiated air containing sulphur compounds, or reducing gases. It must, therefore, be protected by some covering of varnish or other protective agent. (Experiment 12.) It is difficult to preserve the green with permanency on buildings in large towns in this country, although it is seen in comparative preservation as a roof covering in Russia, Italy, and Austria.

Although metallic copper may be kept unchanged in a solution of salt when the metal is entirely covered with the solution, it apparently undergoes a change similar to that just described, when it is alternately exposed to the action of salt water and air. The action in this case probably consists of the conversion of the copper first into oxide, and then the decomposition of the oxide by the sodium chloride:—

$$4\,CuO + 2NaCl + H_2O =$$
$$\left\{ (CuCl_2 .\ 3\,(CuO) \right\} + 2NaOH$$

The surface of the copper becomes corroded, causing, under certain circumstances, considerable loss of copper. The employment of alloys of copper with zinc, or copper containing a small per-centage of phosphorus, partially prevents or, at least, retards the action of saline solutions. The analysis of some copper wire which had been exposed at different times to the alternate action of salt water and air, and which in consequence had become quite brittle, showed also the presence of a considerable quantity of cuprous oxide.

Copper Alloys.—Copper forms a very large number of alloys with other metals, of which those known under the general name of brass are employed for many structural operations. The nature and quantities of the other metals present in some of these alloys varies to a great extent, and we are therefore compelled to select from them, only such as illustrate the general properties and uses of these alloys. The following Table gives the approximate composition of some typical copper alloys:—

	Copper.		Zinc.		Tin.		
	Max.	Min.	Max.	Min.	Max.	Min.	
Bronze	95·0	71·4	10·0	1·0	10·0	1·0	
Gun metal ...	91·0	...	...	...	9·0	...	...
Aluminium bronze ...	90·0	...	...	...	...	...	Al. 10·0
Bell metal ...	76·5	75·8	...	...	25·2	23·5	
Brass	72·0	63·0	34 0	27·0	...	...	...
Muntz	62·0	60·0	40·0	38·0	...	...	...
Aich's metal.	60·0	...	38·80	...	...	...	Fe. 1·2
Stereo metal.	55·0	...	42·4	...	...	...	Fe. 2·6

Brass, which is now much used for structural work, varies greatly in its composition, from the red coloured varieties containing the high percentage of copper, to the yellow varieties like *Muntz metal*, containing about 60 per cent. If the alloy contain about 68 per cent. of copper, with 32 per cent. of zinc, it would correspond to a chemical formula of Zn_2Cu; a compound of zinc and copper which has been isolated. Ordinary brass, therefore, may be considered as solutions of this alloy in differing quantities of copper. When ordinary brass is melted, a small quantity of the zinc always passes away as vapour. Small quantities of tin and lead are added to brass when the metal has to be cut or trimmed by tools. A darker covering (bronzing) may be given to the surface of brass by the application of certain substances such as arsenious oxide in hydrochloric acid, or a mixture of mercuric chloride with acetic acid. A coating of a bronze colour composed of arsenic and copper is obtained in the first case, whilst in the second the mercury is displaced by the zinc, and forms a dark amalgam with the copper. An almost black coating is given to brass instruments by a solution of platinic chloride, the zinc of the brass decomposing the platinum salt, and reducing that metal upon the surface of the alloy—

$$PtCl_4 + Zn_2 = 2ZnCl_2 + Pt.$$

A special variety of brass of the yellow coloured alloys is *Muntz metal*, much employed for sheathing ships. This variety can be rolled when hot, and containing as it does a lower quantity of copper but more zinc, is apparently less acted on by the sea water, and less liable to permit of the attachment of sea animals to the vessels.

Gun metal is an alloy ranging from 90 per cent. of copper with 9 per cent. of tin, to 84 per cent. of copper with 16 per cent. of tin, and from its great strength is used for strong castings, and under circumstances where the alloy has to withstand corrosion. In the manufacture of the alloy, the tin is usually melted first with a certain quantity of copper, when an extremely hard alloy is formed, having apparently a definite composition agreeing with the formula Cu_4Sn. The remainder of the copper necessary is then fused in the reducing flame, on the hearth of a reverbatory furnace, and the hard alloy thoroughly mixed with it with constant stirring. If old gun metal is mixed with the metals during fusion, it generally facilitates the mixing of the alloys. Great care is necessary in the casting of this alloy, as it is liable to a separation of an alloy of the two metals of less specific gravity than the original, and consequently, having a tendency to rise to the surface of the casting. It is supposed that this alloy bears some relation to the composition Cu_3Sn.

Aluminium Bronze contains about 10 per cent. of aluminium, and is an alloy now coming into considerable use. This alloy is like gold in appearance, and has been used to replace it for ornamental purposes, but it does not retain its brilliancy like that metal. It is as hard as iron, and may be used to replace mild steel in cases where any corrosion is likely to take place.

Copper enters into the composition of many other alloys but as it is present in these in much smaller quantities than in those just described, their consideration will be taken with the metal which is their chief constituent.

Lead.—It is doubtful whether this metal exists native; if it does so, it is in extremely small quantities, but it exists to a very large extent in combination as sulphide in *galena* (PbS); as carbonate in *white lead ore* or *cerrusite* ($PbCO_3$); and as sulphate in anglesite ($PbSO_4$). Many other metallic ores are found associated with those of lead, among which the most common are the sulphides of zinc and of silver.

The extraction of lead from its natural compounds may be carried out according to three different reactions.

The first method gives a remarkably good instance of the reaction mentioned in the second division of general reductions, in which advantage is taken of the decomposition, when an oxide and sulphide of certain metals are together raised to a high temperature (the process of self-reduction). Galena itself when heated in a free current of air undergoes considerable conversion into PbO, this considerably assisting the final change—

$$PbS + 2(PbO) = Pb_3 + SO_2.$$

(Experiment 13.)

The tendency of PbS to be oxidised into the sulphate ($PbSO_4$) is of little consequence, as that latter substance undergoes decomposition itself with the sulphide at high temperatures:

$$PbSO_4 + PbS = Pb_2 + 2\,SO_2.$$

Although these reactions may express the final results of the change, some doubt has recently been thrown upon them as expressing the true change during the operation. It is maintained by some that the chief portion of the sulphur is removed as SO_2 leaving a product containing a small per-centage of sulphur. This on melting, allows the greater part of the lead to separate, a slag of the composition ($PbS.PbO$) being formed, which can be removed by thickening with lime. It is also stated that a volatile compound, $PbS.SO_2$, is formed, constituting the lead fume which accompanies the decomposition.

In the third method the galena is desulphurised by iron at a high temperature—

$$PbS + Fe = FeS + Pb.$$

In consequence of some varieties of lead when first obtained from the ore containing small quantities of antimony, it possesses a certain degree of hardness which unfits it for some of the uses to which it is put. This lead is softened by mere fusion in a reverberatory furnace, which removes the antimony. It is remarkable at first sight that antimony, which is less oxidisable than lead, should be removed from the latter by mere heating; it must be remembered, however, that antimony probably forms during the heating antimonic oxide (Sb_2O_5), which unites with the lead oxide, forming antimonate of lead, and is so removed in the dross. By further treatment this dross yields an alloy of lead and antimony, used in casting type castings for printers.

In connection with the extraction of lead there are many interesting points relating to the separation of other substances from it, notably the separation of silver by Pattinson's process, but they are of too purely metallurgical interest to warrant their consideration in the present course.

The importance of lead depends greatly upon its softness and fusibility, which is greater than any other of the metals, except tin, taking place as it does at 325° C. Its softness permits of its being drawn into pipes, or rolled out into thin sheets capable of being easily cut. It is much employed as a covering for roofs, for which it would be better were it lighter and less fusible, as it becomes dangerous in the case of fire.

Another most important property is its inactivity with acids. It withstands the action of dilute hydrochloric and sulphuric acids, and is little acted on by nitric acid (Experiment 14). The metal is therefore peculiarly applicable in certain chemical processes, such as the manufacture of hydrofluoric or sulphuric acids, where chambers made entirely of metallic lead are employed. Strong sulphuric acid when heated with the metal does undergo decomposition in the same manner as it does with heated copper, already referred to.

In considering the actions which are likely to take place upon lead when employed in connection with building and such like purposes, it will be found that the oxides and the carbonates are the compounds upon which the most of the changes occur. It will be useful therefore to examine shortly the properties of the most important of these.

The most important of the lead oxides are the monoxide (PbO), commonly known as *litharge* or *massicot*; *red lead* or *minium* (Pb_3O_4); and lead peroxide (PbO_2), *puce oxide of lead*. Those of less importance are lead suboxide (Pb_2O), and the sesquioxide (Pb_2O_3). The suboxide, when produced artificially, is a black powder, and is supposed to constitute the dark coating which gradually forms on bright metallic lead when exposed to the air. When the monoxide is heated to a moderate temperature, it forms the yellow powder massicot, but, as the temperature rises, the oxide melts, and in cooling forms the reddish brown scales of litharge. Litharge is decidedly soluble in water, especially on boiling, a circumstance that we shall see immediately bears importantly on the use of lead and its compounds for building purposes. (Experiment 15.) From the attraction which this oxide of lead appears to exercise to silica, and from its desiccating action upon oils, a cement used by builders (*Dhil mastic*) for repairing stones can be made from it, by mixing into a paste with linseed oil one part of massicot with about 10 parts of brick dust. The setting of this mass is probably due to the formation of lead silicate and to the drying action of the lead oxide on the oil.

Red lead comes under our notice as one of our common preservative pigments. It is made by heating PbO at a temperature below 316° C., otherwise oxygen is evolved. Its composition varies from $2(PbO)\ PbO_2$ to $3(PbO.\ PbO_2)$, the last being the composition generally found in commercial red lead. When acted upon by dilute nitric acid the PbO is dissolved forming lead nitrate, and the brown PbO_2 is left, showing that the original red lead is probably a weak compound of the oxide and peroxide of lead. (Experiment 16.)

The only other salt of lead the properties of which bear directly on the question of structural materials is the basic carbonate $\{2(PbCO_3).\ Pb(OH)_2\}$ or white lead. A normal carbonate $PbCO_3$ exists as the mineral cerussite, but it is only necessary to mention its name, the basic carbonate being the most important, as it is the constant product of the action of common air and water on metallic lead.

White lead is made by various processes, which all, however, depend upon the same principle, namely, the formation of some basic salt of lead which is finally decomposed by carbon dioxide. The lead salt generally employed is the basic acetate, from which it may be made either slowly, according to the Dutch method, or more rapidly, by passing a current of CO_2 through the solution of the salt. In the older or Dutch method, which yields the best product, it is formed by exposing grated sheets of pure lead placed over pots containing vinegar to the combined action of air and carbon dioxide; these pots are built up into heaps alternately with layers of spent tan, the whole stack being finally covered with the same material. The metal is thus placed under the best conditions for being converted into oxide, a portion of which unites with the acetic acid forming the basic lead acetate, which, in its turn, becomes decomposed by the carbon dioxide into carbonate. This last uniting with a portion of the lead oxide, is finally converted into the basic carbonate. The basic carbonate can also be quickly formed by passing a stream of carbon dioxide gas through a solution of basic lead acetate, but the product of this reaction does not possess the pigment qualities of the slower made substance. (Experiment 17.)

The most important points concerning the deterioration of lead materials are related principally to those actions which produce either the oxides or carbonates of that metal.

We have already seen that oxide of lead is soluble to some extent in water, and the action of moisture alternately with CO_2 produces a rapid action on metal plates and pipes, converting it into basic carbonate. When only moisture and air are present, the oxidation is superficial, and may in many cases act as a protective covering; but when CO_2 is present, especially with an organic acid, the carbonating of the lead proceeds quickly, and the metal may be entirely converted. With the action of waters upon lead, very variable conditions are found. Pure water containing no mineral salts acts with considerable energy on lead, but those waters which contain salts such as sulphate or bicarbonate of calcium do not take up the lead, as the oxide is partially insoluble in solutions of these salts. (Experiment 18.)

EXPERIMENTS ILLUSTRATING LECTURE II.

1. Same experiment as described in No. 9, Lecture I. (p. 869).

2. (*a*) Solution of ferrum redactum in sulphurous acid, is filtered into a solution of potassium ferrocyanide, when the white potassio-ferrous - ferrocyanide is precipitated. (The bottom of the funnel must dip below the surface of the ferrocyanide solution.) (*b*) Solution of ferric chloride added to potassium ferrocyanide, when a blue precipitate is obtained.

3. The white precipitate from No. 2 (*a*) is poured out on a plate, when the white precipitate gradually changes to light blue from oxidation.

4. Nitric acid, added to colourless solution of $FeSO_4$. Dense brown fumes are given off in the liquid, and the colour changes to a dark yellow. The solution now gives the reaction of a ferric salt.

5. Water in which ferrum redactum has been suspended, and through which a current of CO_2 has been passed, poured out upon a plate, the clear solution gradually deposits a crust of $Fe_2O_3.3(H_2O)$ at the edge.

6. A slip of metallic iron placed in a solution of copper sulphate and withdrawn after a minute or two, will be found covered with a brown coating of metallic copper,

7. Cuprous oxide, previously dissolved in strong ammonia and kept out of contact of air poured out on a plate, rapidly becomes blue.

8. Cotton having been previously dissolved in the blue copper solution (Schweitzer's solution), the solution was poured into a large volume of acidified water, when the cotton was precipitated.

9. A strong solution of cupric chloride was poured into a tall jar of acidulated water, when the green stream at once became blue on dilution.

10. A colourless solution of cuprous chloride oxidised by a drop or two of nitric acid, rapidly becomes blue, being converted into the cupric salt.

11. A perfectly clean sheet of copper must be first rubbed with dilute hydrochloric acid, and then with ammonium chloride. When this has acted on the copper for some time, the sheet is farther rubbed with a moist paste of chloride of lime. A good green coating may be obtained on the copper in a fairly short time, but to obtain a good result the experiment requires time and attention.

12. When the coating formed in No. 11 is brushed with a solution of potassium hydrosulphide it is at once blackened.

13. The same experiment as No. 10, Lecture I.

14. Slips of lead placed in dilute hydrochloric, sulphuric, and nitric acids, when little or no action on the metal takes place.

15. Lead oxide is shaken with distilled water and filtered. On testing with litmus paper, the solution is seen to be alkaline, and on testing with H_2S a brown colouration of PbS is observed.

16. Red lead treated in a flask with nitric acid at once loses its bright red colour, leaving the brown peroxide.

17. A current of CO_2 gas is passed through two wash bottles containing solutions of acetate and basic acetate of lead. No precipitate is formed in the solution of the acetate, but a dense white deposit of basic carbonate is formed in the basic acetate solution.

18. Slips of lead were placed in (*a*) distilled water, (*b*) tap water, and (*c*) solution of calcium sulphate; on testing for lead, a deep reaction is given by *a*, slight by *b*, and scarcely any by *c*.

Miscellaneous.

AGRICULTURE IN THE ALPES MARITIMES.

The visitor who goes to the Riviera in search of health or pleasure during the winter months, and who confines himself to the fashionable towns on the coast, would not be inclined at first sight to consider the department of the Maritime Alpes as an agricultural district. It is, however, strictly one of the agricultural departments of France. There are few manufactures. The most important are the perfumery factories of Grasse, which consume a great quantity of cultivated and wild flowers, as well as aromatic plants grown on the coast, and among the mountains of the department. The Acting British Consul at Nice, in his last report, states that the department contains 373,800 hectares (hectare = 2·47 acres), of which 73,764 hectares are ploughed land, 61,441 hectares are planted in vines, 19,513 hectares in timber, 20,774 hectares are meadows, and 90,000 hectares grazing ground, or "Alpes;" of the remaining territory, 55,942 hectares are built over, or used for roads and ways of communication, while 52,363 hectares are uncultivated, or barren. The soil is naturally fertile, and produces well where it can be irrigated by means of the canals. A great deal of the cultivation is done on the terraces made on the mountain sides, every kind of crop being grown on them, from olives to cereals. Wheat, meslin, rye, barley, and oats are grown, but not to any very great extent. In 1894, 20,941 hectares out of 61,414 hectares planted in vines, gave 36,298 litres of wine, as against an average of 49,092 litres. The wine produced in 1895 was very abundant, but not of such good quality as the vintage of 1894. The wines, as a rule, are inferior, but near Bellet they make a wine which some consider excellent. Besides the wine grown in the country, and the *vins fins* imported for the consumption of the well-to-do classes and foreign visitors, large quantities of inferior wines are imported from Spain and Algeria into Nice, Cannes, Antibes, and Mentone. These wines are often doctored, and generally are what is termed *platré*, and are not very wholesome. There is more wine drunk per head of the population in Nice than in any town of France. Market gardening is carried on chiefly near Nice, towards the Var, at St. Laurent-du-Var, Cagnes, Antibes, Vallauris, and Cannes. Some of the gardeners make a specialty of *primeurs* for the London and Paris markets. At Nice there is a trade in dried vegetables. These, as well as candied fruits, are largely sent to Bordeaux, from whence they are exported to England. Fruit culture has made great strides of late years, owing to the extension of the candied fruit trade. Among the fruit trees whose cultivation can be considered of the first importance come the peach, the fig, the plum, cherry, orange, and, at Mentone, the lemon. The olive tree of the Riviera is cultivated for its oil. The dry and calcareous nature of the soil being admirably suited to the cultivation of the peach, the *Persica Amsden Junæ*, a native of the United States, is successfully grown in the open air, the fruit ripening from about June 1 to June 10; the peach tree suffers principally from the presence of ants. The fig tree is much cultivated in the department, and its fruit is both sold fresh in the market, or candied and dried. The dried figs of Nice are consumed locally. Three lbs. of fresh figs giv one lb. of dried figs. Dried figs of prime qualit fetch from 40 to 60 francs the 100 kilogrammes. Th Arabs of Algeria manufacture a kind of spirit, known as *Araki*, from the dried figs, and the peasantry o Nice and the Genoese Riviera make a kind of swee wine from this fruit. The tree gives two crops ever year. It requires careful cultivation, and to b judiciously cut. Like all other fruit trees in th Riviera, the fig suffers greatly from insects. Cherrie are very plentiful, and the fruit is largely used locally in the manufacture of bonbons, preserved in brandy and candied. The crop has not been so good this year as in 1895 or 1894. Orange and lemon trees ar largely cultivated all over the coast districts; besides the climate, the soil is very favourable to these trees as they require a calcareous one, rich in lime and potassium. They generally die, if the temperature falls below 23° Fahrenheit. The common orange tree cultivated at and near Nice (the *Citrus aurantium*) produces its maximum at about 20 years of age. This may be calculated at 600 to 1,000 oranges per annum, 1,000 oranges weighing about 150 kilogrammes. They are, however, principally cultivated for their flowers, which are sold at 40 centimes per kilogramme, or about twopence per lb. With the skins of the orange an essential oil is made, both at Nice and Grasse, which is called essence de Portugal. The bitter orange tree, or *Citrus Bigardia*, is cultivated for its flowers, which produce a kind of water much used in France, called *eau de fleur d'orange*, and also an essence. The skins of these oranges are dried in the sun, and are exported to England, where they are used for making cakes and puddings. Dr. Emile Sauvaigo, in his book, "Les Cultures sur le Littoral Méditerranéan," estimates that the average annual income in the Alpes Maritimes derived from the cultivation of the olive, is £320,000. In spite of this, the cultivation is on the decline. Dr. Sauvaigo gives the following reasons for this—"The competition of grain oils, such as cotton seed, &c., and the numerous frauds and adulterations practised in the olive oil trade, and besides these there are the dearness of labour, faulty pruning and insufficient manuring, and last, but not least, the increase of the parasites of the olive tree." The tree grows best on slopes, and prefers a dry soil, rich in carbonates of potassium, lime, and magnesia. It suffers from cold, and dies at 14° Fahrenheit. On the Riviera, a tree planted from a seed begins to bear fruit in about 13 to 14 years, and those planted from cuttings in about 8 years. It flowers in April. In August, when the fruit is well-formed, it suffers most from its enemy the *Keiroun*. One of the most difficult things in olive culture is the pruning of the trees, and this has to be done as soon as the crop has been gathered, or after severe cold weather. As regards reproduction (and this, says Consul Jerome, may be of special interest, as on one or two occasions the consulate has been asked by the London representatives of the Colonial Government to obtain seeds and young grafted olive plants, to be sent to the Colonies for plantation), this is effected, first by seeds. The ripest and finest olives are chosen, the stones are separated from the pulp, and they are spread out to dry in the autumn, and planted in the spring. They take about a year to come up, but if the stones are broken, without any damage being done to the kernels, and by sowing these in February or March, the young plant makes its appearance much sooner. The seedlings, after having been kept in a nursery garden for about four years are grafted. Dr. Sauvaigo recommends graftings on the wild olive (oleaster), or on suckers, and these should be chosen as far from the parent tree as possible. Olive trees are also reproduced from cuttings. In all cases care must be exercised that the young plants should be taken from the nurseries just before winter or the rainy season, so that they should benefit by the natural moisture of the soil. The crop is gathered by women and children at the rate of 1 franc to 1 franc 50 centimes per day. The fallen fruit is picked up under the trees during the winter, and in April or May the trees are beaten. If the olives cannot be immediately taken to the mill, they are stored in heaps, which have to be stirred to prevent fermentation. The olives are usually sold to the manufacturers of olive oil, at the rate of from two to four francs the double décalitre (20 litres), according to the quality. The oil produced at the mill can be divided into several kinds:—(1) Virgin oil, or the oil pressed out and carefully filtered several times; (2) the first quality oil of commerce, or the oil scalded in vats, which is a much quicker process, but somewhat spoils the quality of the oil; (3) *Huile de ressence*, or refuse oil, used as a rude sort of lubricator oil by the peasantry. An olive orchard brings in an average income of £20 per annum for each hectare, and the land is valued at from £200 to £480 per hectare. The diseases the tree suffers from are numerous, the most formidable being known in the district as *la fumagine*, caused by a small fungus. The mills where the olive oil is made are, as far as machinery goes, of a very primitive character, generally driven by water wheels. These are defective in construction, and the fall of the water badly arranged. The machinery inside the mills is made of clumsy wooden cogs and contrivances. Consul Jerome says he is sure that improved machinery for making olive oil would find a ready sale in the South of France and Italy, providing that it was not of too complicated or expensive a character.

THE WOODS OF SAMOA.

Much has been written about Samoan woods, their beauty, abundance, and variety, but, says the United States Consul-General at Apia, there is but little foundation for the statement that these woods are likely to become a source of marvellous wealth. There can be no question but that the variety of woods is very extensive, and that a limited proportion may in time become valuable. Most of the Samoan woods are very soft and light, which, after becoming well dried, lose not only a great proportion of weight, but become brittle, and of no practical worth to sustain lateral strain. In addition to these, there are several varieties of hard woods, such as the *ifelele*, *talia*, *pau*, *toi*, *nisla*, *tau*, and the *ifi* (*Inocarpus edulis*), which can scarcely be said to be abundant. Several of these are beautiful, very hard, and susceptible of a high polish. One or two varieties grow to a fine size, and are in request among the natives for making kava bowls—wide shallow vessels, hollowed out from cross sections of the butt of the tree, generally from 18 inches to 2 feet in diameter, and sometimes reaching 3 ft. 6 in. in width. Woods employed for this purpose would doubtless cut into veneers, were there a demand for their peculiar colour and grain by the fancies of fashion. Such, however, does not at present exist, and there is no probability that the mere eccentricity of taste will take a direction to create a demand. A large amount of hard wood is used in making the common canoe of the natives. These are mere logs, hollowed out, and the largest with rare exceptions, would not require a log of more than two or three feet in diameter. These canoes are hollowed laboriously out of the log, on the ground where the tree is felled, being hewn away until the boat is a mere shell of from 1 to 1½ inches in thickness, except at the bow and stern. When thus lightened to a minimum, they are dragged and carried to the water. While large trees are numerous, they are not in proportion to the extent covered by the forest, or to that common in a country of merchantable timber, plentiful, or found close together. The dense character of the tropic forest, the deep shade, moisture, and heat, has naturally, in such a climate, the influence of so thickly crowding the surface with shoots and young trees, that the forest is a mass of slender saplings, overcrowded and dense, all under the stimulus of the need of light and air, towering to reach the open space above. In such a bush, the large trees having attained size on some principles of survival of the fittest, abound in necessarily limited abundance. These large trees, of nearly all varieties, flare out at the butt in ribs or inverted brackets until they cover a space at the surface of from 12 to even 20 feet. The woods are not of straight grain, but are twisted, knotted, gnarled, and contorted in shape, and this bent and knotted quality in the hard and tough varieties produces a most excellent material for knees in small and medium-sized wooden vessels, for which it is much used. In a general sense, it is, perhaps, in this employment that Samoan woods find their greatest value. Much was expected in years gone by from the production of fibres, and an array of plants was cited producing fibres of a merchantable character. The intervening years have allowed the shipments of various samples to Europe for experiment, but the experiments were such that no encouragement or demand followed. The fibre obtained from the covering of the cocoanut is practically the only one produced in the Samoan islands. This article is well-known to commerce, and long ago took a place in the manufacture of mats, and to some extent, as a substitute for hemp in twines. In all cocoanut-growing countries, it is of course abundant in proportion to the production of mats. In Samoa it is used by the natives in making all the twine and small rope their needs require, and does not enter into export.

Correspondence.

FOREIGN TRADE.

You will pardon me for sending you some of my recent literature, as it is very important that the *Journal of the Society of Arts* should be well posted up and accurate in what it publishes.

My attention has been called to your issue of the 9th October and your remarks on "Foreign Trade" (see *ante* p. 857). It is a fact—and a very surprising and remarkable fact—that the foreign trade of the United Kingdom has not increased to the extent of a single shilling during the last 25 or 30 years!

This fact, after what you have published, should be distinctly stated in a future number of the *Journal.*

MASHAM.

Swinton, Masham, Yorkshire.
October 20th, 1896.

General Notes.

MUNICH INTERNATIONAL ART EXHIBITION, 1897.—Information respecting the seventh International Art Exhibition, to be held at Munich in 1897, under the patronage of H.R.H. the Prince Regent of Bavaria, has been received from the Science and Art Department. The German Ambassador in London has written to the Secretary of State for Foreign Affairs, at the request of the Royal Bavarian Government, inviting the Marquis of Salisbury's attention to this proposed exhibition, and expressing the hope that academies and artists may be induced to send works for exhibition. It is stated that the exhibition to be held next year will be carried out mainly on the lines of the rules of the exhibition of 1892. Applications for further information respecting the exhibition should be addressed to the Central Committee, Royal Crystal Palace, Munich.

RUSSIAN SAVINGS BANKS.—On December 31, 1895, the amount standing to the credit of depositors in savings banks throughout Russia amounted to 377,165,352 roubles, the deposits having been made by 1,886,453 persons. During the same year, 717 new branches of the Government savings bank were opened, 769 such branches having been newly established in 1894. In 1884 there were only 75 branches, and 61 of these were in connection with the Imperial State Bank. In 1885 they numbered 161; in 1890, when the system of savings banks was first extended to post and telegraph offices, there were 841 in existence; in 1895 their number had attained 3,907, of which 3,100 were in connection with post and telegraph offices. The development of savings banks in Russia is favourably regarded and encouraged by the Government, inasmuch as the sums deposited in them are under the complete control of the Minister of Finances, and afford convenient means for investment in new railway and other Government stock, the market price of which is thereby firmly supported.

POPULATION OF ITALY.—When the first census of Italy was taken on December 31st, 1861, the population of that country, including Venetia and the province of Rome, amounted to 25,000,000. Ten years later (December 31st, 1871), the population of United Italy amounted to 26,801,154. On December 31st, 1881, it had increased to 28,456,628. In 1891 it reached 30,118,102, and on December 31st, 1895, it amounted to 31,684,267. The births have exceeded the deaths in the following ratio:—In 1882, 9·6; 1885, 11·7; 1890, 12·8; and in 1894, 10·6. The most recent statistics show that in 1894 there were 231,581 marriages, 1,102,935 births, 776,372 deaths, and 46,256 still-births. There has been a falling off in marriages during the last five years in comparison with the eight preceding years. In 1894 the rate of births per 1,000 inhabitants was 35·9. The mean rate for the period 1882–1890 was 27·96. The death rate per 1,000 inhabitants was 27·14 for the period 1882–1890; 26·45 in 1892; 25.44 in 1893; and 25·27 in 1894. The number of still-births has increased, the per-centage in 1894 being 5·09 per 100 births in the province of Rome, but only 2·8 per cent. in Calabria.

PRODUCTION OF AMERICAN CHEESE. — A recent report of the United States Department of Agriculture shows that nine-tenths of the cheese produced in that country comes from the States of New York, Wisconsin, Ohio, Illinois, Vermont, Iowa, Pennsylvania, and Michigan, in the order of their importance. The State of New York turns out half the total product, and the production of this State and that of Wisconsin represents more than two-thirds of the total. The cheese made annually in the United States necessitates the use of milk from about 1,000,000 cows, and its value varies between 20,000,000 and 25,000,000 dollars. In spite of the importance of the home production, the United States imports annually about 9,000,000 pounds of foreign cheese. The annual rate of consumption, which shows a slight tendency to decrease, is actually about 3 pounds of cheese per head of the population. The production amounted to 105,000,000 pounds in 1849; 103,000,000 in 1859; 162,000,000 in 1869; 243,000,000 in 1879, and 256,000,000 in 1889. The exports amounted to 81,000,000 pounds in 1893, 74,000,000 in 1894, and 60,000,000 in 1895.

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FRIDAY, OCTOBER 30, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors shall send in descriptions of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CERTAIN METALS AND THEIR COMPOUNDS USED IN BUILDING, AND THE CHANGES PRODUCED ON THEM BY AIR, MOISTURE, AND NOXIOUS GASES, &c.

By Prof. John M. Thomson, F.C.S., F.I.C.

Lecture III.—Delivered March 3, 1896.

Zinc.—This metal may very conveniently be taken into consideration after lead, from its high position as a useful metal and from such usefulness being dependent on properties directly in contrast to those which give importance to that metal. The specific gravity of lead being 11·5, and that of zinc 7, its lightness renders it useful for the construction of tubes, sheets for roofing, &c., under circumstances where lead, on account of its weight, is inadmissible. It will be found, however, that its resistance to corrosive action is much less than lead, although it may be considered more than iron; hence its use for galvanising that metal.

The sources of zinc are fairly abundant in England, but it exists to a larger extent in Belgium and Germany. The chief ores are the sulphide or *blende* (ZnS); the carbonate ($ZnCO_3$) or *calamine*; and an oxide (ZnO) or red zinc ore. There are other ores less common, such as a basic carbonate $\{ZnCO_3.\ 2.(Zn(OH)_2)\}$ from Spain, and a peculiar mineral, electric calamine, *hemimorphite*, which is a silicate $2(ZnO.SiO)_2.H_2O.$, and which possess the property of becoming electrified when heated.

The extraction of this metal is a matter of comparative ease from its volatility and easy fusibility (415° C.); and is carried out by the conversion of the ores first into oxide and the final fusion of this body with carbon—

$$ZnO + C = CO + Zn.$$

It is of importance to note that this reaction differs somewhat from those we have already seen in the extraction of metals. In the decomposition of ZnO a large amount of heat is absorbed, an amount considerably larger (56 cals.) than the amount of heat evolved in the formation of the CO during the reaction. This quantity has therefore to be supplied by the outside furnace to the retort in which the decomposition is taking place. Such a reaction is spoken of as *endothermic*.

The crude zinc at first obtained almost invariably contains lead and arsenic as impurities, the former of which much interferes with the rolling of the zinc into sheets. To purify it, the crude metal is merely heated in a reverberatory furnace with a depression at one end; when from the high specific gravity of lead, and the fact that zinc at 400° C. is not capable of dissolving more than 1·5 per cent. of that metal, the lead on fusion sinks to the bottom and the top layer of zinc may be removed. (Experiment 1.) Zinc shows some interesting changes in its properties when examined at different temperatures. It may be broken at the ordinary temperature, showing a distinct crystalline structure, but at 121° C. it becomes malleable and can be rolled into thin sheets, becoming again friable at 204° C. In contact with air bright zinc becomes tarnished with a film of oxide which passes gradually into basic carbonate, which prevents the further action of the air.

We have already seen in the general action of acids on metals that common zinc readily decomposes dilute sulphuric acid. If, however, we place pure zinc in sulphuric acid we find that although at first a certain amount of action apparently takes place, this almost immediately ceases. This is due to the zinc being coated with bubbles of hydrogen which prevent the acid further attacking the metal. On bringing the zinc however in contact with another metal, such as copper, silver, or platinum, action at once takes place, due to these metals being electro-negative to zinc and attracting the electro-positive hydrogen, thus leaving the zinc free for the further action of the acid. (Experiment 2.) The metallic impurities in common zinc are electro-negative to the zinc, and so assist it in the decomposition of the acids. Such facts we will find of great importance when we consider the general questions relating to the permanency of metals.

In consequence of zinc occupying an electro-positive position to certain other metals, several processes have been proposed for obtaining the metal from solutions of its salts by galvanic reduction. The salt employed is usually the sulphate, into which the natural zinc sulphide may be roasted, or into which it may be converted by ferric sulphate, in much the same manner as Siemens' and Halske's method for the deposition of copper :—

$$ZnS + Fe_23\,(SO_4) = ZnSO_4 + 2FeSO_4 + S.$$

the solution of zinc sulphate is thus electrolysed. In Siemens' and Halske's process the ferrous sulphate becomes reoxidised into ferric sulphate during the electrolysis.

In the neighbourhood of large towns, and for work in exposed districts, zinc has been ingeniously used for the coating and protection of iron, so combining the strength of the iron with the durability of the zinc. This process is termed *galvanising*, and consists in first clearing the surface of the iron to be coated, by scrubbing with sand and dilute hydrochloric acid, and then passing the cleaned metal through a bath of melted zinc covered with ammonium chloride. (Experiment 3.) This latter substance acts through the property it possesses of being able to dissolve the zinc and its oxide; and probably the sal ammoniac acting on the heated zinc dissolves the metal forming $ZnCl_2$, this latter dissolving the oxide and removing it as zinc oxychloride (Experiment 4) :—

$$Zn + 2\,(NH_4Cl) = ZnCl_2 + 2NH_3 + H_2.$$

Small quantities of tin are sometimes added to the zinc bath, or a thin film of that metal is formed on the sheet of iron before it is introduced into the bath. The hard zinc which is formed by the passage of some of the iron into the bath sinks to the bottom, and is removed from time to time. The various forms of iron differ considerably in the ease with which they can be covered, cast iron and hard steel being less easily coated than wrought iron and the other varieties. Any fault which may exist in the use of zinc as a covering material for iron lies apparently in the two metals forming an alloy of weak strength on the actual surface of the iron, and beneath the outer portion of the zinc coating. The method, therefore, acts best on iron materials of some thickness, and less efficiently for the covering of fine wires, &c. In withdrawing the material from the bath, it generally passes under brushes and rollers to remove excess of zinc.

In connection with the salts of zinc, only two may be mentioned in relation to the present course; these are the oxide (ZnO) and the chloride ($ZnCl_2$). The former constitutes the paint termed zinc or Chinese white, which may be used as a mechanical preservative; and as its sulphide (ZnS) is of a white colour, it does not change under the action of sulphurous gases, and so may be regarded as a permanent white.

Zinc chloride ($ZnCl_2$), obtained by dissolving the metal or oxide in hydrochloric acid, or by distilling a mixture of zinc sulphate with sodium chloride, is of importance, from the property it possesses of cleansing metallic surfaces. It does so by removing the oxide from the surface of the metal, and for this reason it is employed in soldering, a process which we will examine later.

Tin.—This metal is rarely used by itself except for the manufacture of pipes and metal work which come in contact with water, as it is almost the only common metal which entirely withstands the action of that substance even in the presence of carbonic acid. Its chief ore is *tin-stone* (SuO_2), and from this it is extracted, after a series of preliminary operations, by finally fusing with coal.

The metal first obtained from the ore is contaminated with small quantities of iron, arsenic, copper, and other bodies from which it may be separated by liquation, which is facilitated by the low fusing point of the tin (227° C). The specific gravity of the tin also being low it remains, to some extent, mixed with the dross resulting from the fusion of the ore, and to remove this the somewhat ingenious device is adopted of plunging wet billets of wood into the molten metal when the bubbles of steam rising through the metal cause the impurities to rise and collect on the top.

Tin is a remarkably lustrous metal resembling silver in brilliancy, but easily distinguished from that metal by its fusibility and its oxidation when heated in air. It is malleable at the ordinary temperature and capable of being rolled as tin foil, but becomes brittle at 200° C. It decomposes steam at a red heat, but is scarcely affected by water or air, thus becoming useful for covering iron in a manner similar to zinc. Certain varieties of the metal, however, namely that deposited upon zinc from neutral solutions of a tin salt, or the powdered variety made by shaking melted tin in a wooden box till cool, do undergo oxidation to a considerable extent at the ordinary temperature. When exposed to very great cold tin becomes gradually converted into a crystalline modification which gives it a grey appearance. A spontaneous disintegration of the metal may take place from this cause, and the change which takes place in organ pipes in very cold climates has been attributed to the conversion of the tin into the grey modification, probably aided by the vibrations of air in the pipes.

Tinning of Iron (*Tin-plate*).—This material is made by coating sheets of iron with metallic tin, much in the same way as already described in the case of zinc. The sheets of iron having been thoroughly cleaned from every trace of oxide by alternate treatment with dilute acid, heating, rolling and final scrubbing with sand, are immersed in a bath of oil so that they may become dry out of contact of air. They are then placed for over an hour in the bath of melted tin, the surface of which is protected from oxidation by a layer of tallow; redipped after draining to thicken the coating of tin; transferred to a bath of hot tallow to allow the superfluous tin to deposit; and finally passed under the brushes and rollers.

The object of heating the iron plates between the various immersions which they undergo in the dilute acid, is to remove the brittleness caused by the absorption of the bubbles of hydrogen by the metallic iron during the pickling.

An alloy of lead and tin is sometimes employed for covering iron in the same manner (Terne plate).

Although the covering of iron by zinc and tin have been especially mentioned as among the commonest methods in connection with large structural operations, there are other means by which protection may be given to metals when required for certain purposes. Of these, the only one I would direct your attention to is that of *amalgamation*, when the metal mercury is used generally for the protection of zinc plates, which are to be used in voltaic cells. (Experiment 5.)

It will be observed that in the zincing or tinning of iron plates, the greatest care is taken to have as close a contact as possible between the two metals, and the reason of this will be appreciated when we consider what we have already seen of the electric actions of metals upon each other in the presence of a third substance. Tin or zinc, more especially the former, being unaltered by the air at the ordinary temperature, will prevent the oxidation or rusting of the iron so long as the coating is perfect, but if a portion of the iron becomes uncovered in the presence of air and moisture, rapid action will take place, as the two metals now form a galvanic couple capable of decomposing the drops of water charged with carbonic acid gas, which fall upon them, and corrosion ensues. There will be a difference, however, in the method of action in the case of the tin and the zinc. In the case of tin, the iron, having the greater attraction for oxygen, will be the metal attacked, but, in the case of iron galvanised with zinc, it is the latter which is the metal acted upon, and hence we may consider this covering the more durable under certain circumstances. (Experiment 6.) Many of the peculiar changes noticed upon metals when so covered, or when brought in contact with each other in exposed situations, are to be accounted for by such actions.

Alloys of Tin, Lead, and Zinc.—We have already discussed certain alloys formed with the metals originally selected for consideration in the course; but we have hitherto confined our examination to those in which copper is the chief constituent, and which are related more particularly to the large class of brass alloys.

Tin may be regarded as one of the chief metals concerned in the manufacture of white alloys, a few of which are employed directly or indirectly in structural work. The following Table gives the approximate composition of some of the more important of these alloys, but I propose to draw your special attention to the properties of only one or two:—

Alloy.	Tin.	Lead.	Antimony.	Copper.
Britannia metal	90·62	—	7·81	—
White metal	82·00	—	12·00	—
Solder (fine)	66·60	33·30	—	—
,, (common) ..	50·00	50·00	—	—
,, (plumbers)..	33·30	66·60	—	—
Bearing metals	84·20	—	10·50	—
,, ,, ...	45·50	40·00	13·00	—
,, ,, ...	20·00	60·00	20·00	—
,, ,, ...	5·00	80·00	15·00	—
,, ,, ...	—	84·00	16·00	—

Solder and Soldering.—Of all the common alloys of tin, those classed under the name of solder are probably those which in the present course should demand our chief attention. From what we have seen with regard to the properties of the individual metals themselves, it will be readily understood, that actions which take place upon them, will also produce similar changes, perhaps more accentuated, on materials or compositions employed for their union in structural operations.

The methods employed for the union or junction of two pieces of metal may be roughly classified under the three headings; autogenous soldering; soldering by formation of an alloy; cementing. Of these, the two last are the ones to which I wish more particularly to direct your attention.

Autogenous soldering is undoubtedly the most perfect method when it can be applied, and consists in joining the surfaces of the material by fusion or semi-fusion. This fusion is effected in the case of soft metals like lead sheets by the flame of a blowpipe, generally oxyhydrogen, or air and hydrogen or coal gas, and is a method employed in the junction of the material in the construction of leaden chambers in sulphuric acid works. Another method of autogenous soldering is seen in the welding of metals, generally iron or steel, where the material does not actually melt, as in the case of the lead, but is brought into a plastic condition, when final union may be effected by hammering, or by pressure. Although this method may be strictly regarded as autogenous soldering, it must be remembered that even the plastic surfaces must be *perfectly* clean before welding, and therefore require preliminary treatment for this purpose. It is customary to employ either sand or borax as a flux to remove the oxide, and the welding may be made still more perfect by placing between the surfaces, in the case of iron or mild steel, iron wire gauze, the meshes of which have been previously filled with fused borax. As the question of proper welding depends so much on the temperature of fusion or semi-fusion of the substances, the difficulty of joining two materials, or even two varieties of the same material (steel and wrought iron) will be understood.

The recent improvements in electricity have assisted the introduction of an electric method of autogenous soldering in which a powerful current of electricity is passed through the bars of the material to be joined. The resistance to the current at their point of contact becomes converted into heat, causing the partial fusion of the metal, which soon reaches a welding temperature. During the process the bars are pressed together, and the joint so formed may be finally perfected by hammering in the useful way. From the high temperature obtainable at the point of junction in electrical welding, it may be used for the union of many metals which have practically very high melting points.

The more common process known as soldering depends upon the use of a fusible substance, itself an alloy, but also capable of forming an alloy with each of the different metals to be united. It is thus necessary that the solder should have a varying composition for the different purposes for which it is to be used, and the numbers given in the Table express the usual composition of the three common varieties. The next essential point is the question of the fluxes, which are various, according to the metals to be joined, and which may be conveniently arranged in two divisions, (*a*), those which exercise purely a protecting action on the surface of the metal, preventing it undergoing oxidation during the process, and (*b*), those which exercise a cleansing action by removing the oxide which may be formed during the process of joining. Of the first class we have substances like rosin, tallow, and vegetable oils; whilst in the second the substances most commonly employed are ammonium and zinc chlorides, and sometimes hydrochloric acid, this last forming zinc chloride when applied to the metal. Allusion has already been made to the action of such cleansing substances in the case of the tinning or zincing of iron; and the action of some of them can be readily seen on a slip of heated and tarnished copper or a sheet of zinc covered with a slight film of oxide. (Experiment 7.)

Apart from the question of fusibility, metals which oxidise readily are the most difficult to solder, as they require particular care in the cleaning of the surface, whereas a metal like copper, with a fairly high fusing point, may be readily soldered with rosin, although it is customary to use zinc chloride as well. Non-oxidisable and, at the same time, fusible metals are, of course, the most easily soldered. Thus for tin, rosin may be accompanied, if necessary, with zinc chloride; zinc requires hydrochloric acid or its own chloride; copper may be soldered with or without a cleansing flux, and a fusible metal like lead, requires only rosin or tallow. Iron is more commonly welded than soldered; but when the latter is done, the surfaces must be cleansed thoroughly, and ammonium chloride used in the flux.

Methods of cementing are little used in the junction of metal work, as compared with their use in other kinds of building operations. There is, however, a cement, known under the name of *rust joint cement*, which is employed in the junction of iron pipes, and which may be mentioned. It is composed of 80 parts fine iron filings, one part of ammonium chloride, and two parts of sulphur, made into a paste with water. When this is packed into the joint it sets into a hard cement, apparently produced by the formation of mixed oxide and sulphide of iron.

Aluminium is another white metal which perhaps at first sight might hardly be considered as common in relation to true structural materials. Its employment, however, in this direction is undoubtedly increasing, more especially where extreme lightness is of importance; and as the metal itself shows some interesting differences from some of those already examined, I have thought it of interest to consider it in our course.

The sources of this metal are widely distributed throughout the globe, but apparently there are only two of its ores, namely, bauxite ($Al_2O_3.3H_2O$) and kryolite ($Al_2F_6.6NaF$), which lend themselves specially for the reduction of the metal, this reduction, already shortly alluded to at the commencement of our course, being effected either by chemical or electrical means.

Although aluminium resembles iron to some extent in its chemical properties, it is found impossible to carry out its direct reduction from the ore with carbon as is done in the case of that latter metal; such a reduction in the case of aluminium involving an absorption of heat. Indirect processes of reduction must therefore be employed.

The old process, now obsolete, of first reducing the oxide mixed with carbon in a current of chlorine gas to form the chloride (Al_2Cl_6), and then the decomposition of the double chloride of aluminium and sodium ($Al_2Cl_6.2NaCl$) with additional sodium, has already been mentioned, but it is now largely replaced by the method of electrical decomposition.

The kryolite is fused in an iron crucible into which alumina is fed from time to time, the temperature of fusion being maintained by the electric current. This addition of the alumina during the decomposition saves the cost of renewal, were a bath of the pure halogen salt used, as it dissolves in the kryolite and becomes itself decomposed by the current instead of that latter body.

The substitution of aluminium sulphide dissolved in a bath of fused alkaline chloride has been proposed as a substitute for the oxide dissolved in the fluoride.

Although aluminium shows such unwillingness to be reduced by itself from its ores, it readily undergoes reduction when its ore is fused with other metals, thus forming an alloy directly from the ore. Such an alloy may be formed by fusing alumina, carbon and copper in an electric furnace, the product containing from 15 to 30 per cent. of aluminium.

Aluminium is remarkable as being the lightest metal which is capable of resisting the action of moist air, both of which properties rendering it an especially useful metal for decorative purposes. It also shows characteristic properties in its capability to withstand the action of nitric acid, even when the temperature is raised, thus differing from all other common white metals. It dissolves, however, in hydrochloric acid with the evolution of hydrogen, and also in solutions of potash or soda, forming so-called aluminates with these alkalies. (Experiment 8.)

$$6\,(NaOH) + Al_2 = Al_2\,(ONa)_6 + H_6.$$

Even when heated in air, aluminium is oxidised to a very small extent, probably on account of the infusibility of the coating of oxide which is at first formed. When finely divided, however, by alloying with other metals, it undergoes oxidation readily. This inertness of the metal towards oxygen, and when pure its resistance to the action of vegetable acids, have largely advanced its position as a useful metal during recent years.

Although aluminium alloys itself readily with metals it does not dissolve in *cold* mercury nor in *melted* lead, both of which exercise distinct solvent action on most metals. One of the great drawbacks originally experienced in the use of aluminium was the difficulty of soldering it successfully; this difficulty apparently arising from the refractory nature of its oxide and the ease with which the metal itself was attacked by both acid and alkaline fluxes. This objection has now been overcome by more modern methods of autogenous soldering.

Aluminium can be rolled into sheets and converted into foil, in which form it is best suited like goldleaf for decorative purposes, although it does not show the brilliancy of silver leaf. The tensile strength of the metal is also increased by the process of rolling and also by alloying it with smaller quantities of other bodies as copper, nickel, silver, or titanium.

The chief alloys which aluminium forms are the aluminium bronzes or brasses, in which it is united with copper, and of which a typical example was mentioned in connection with that metal. When fused with nine times its weight of copper it forms *aluminium bronze*, very like gold in its appearance, but almost equalling iron in strength. This alloy has been recommended instead of gold for decorative work, but does not retain its brilliancy to the same extent and can be easily distinguished from that metal. (Experiment 9.) The alloys containing a greater proportion of aluminium than the bronze, namely, one containing 94 per cent. of aluminium to 6 per cent. of copper, have a very great tensile strength and at the same time great brightness.

There can be little doubt that as the methods for the extraction of this metal in its elementary form became more perfected and less expensive, the use of the metal itself and of its alloys will greatly increase.

I had not intended at the commencement of this course to say anything regarding the noble metals which, so far as building or structural arrangements are concerned, may be placed on one side, except for mere ornamental purposes. There is, however, one of them, namely, gold, which possesses so many marked differences from the commoner metals we have already considered, that I venture to draw your attention very briefly to some of them.

The individuality of gold among other metals lies in its rarity; its peculiar colour; its great weight; its electrical properties; its great ductility; its high fusing point; and its great resistance to withstand the action of air an acids. It is found widely distributed in man quarters of the globe, but generally in comparatively small quantities. In structura work it is employed purely for decorative work as its great malleability permits of its being drawn and beaten into extremely thin sheet (gold leaf), and which, when used as coverings, withstand absolutely the action of ai and noxious gases. It is said that an ounc of gold when so beaten into leaf may be mad to cover 100 square feet.

Gold is unacted upon by all single acids except selenic, and only yields to the action o mixtures of hydrochloric and nitric acids, or t a mixture of sulphuric with a little nitric acid (Experiment 10). We have already seen in an early part of the course the direct action o certain elements, notably chlorine, on metals and the solubility of gold in the mixture o hydrochloric and nitric acids, evidently depend to some extent on the liberation of free chlorine in the reaction :—

$$3\,HCl + HNO_3 = 2\,H_2O + NOCl + Cl_2.$$

The chlorine at the moment of liberation being in a more active condition, and so uniting itself with the gold.

Gold is not deteriorated by coming in contact with other metals, except in the case o mercury, with which it at once amalgamates an action which is sometimes utilised in the extraction of the metal from its impurities.

The methods of covering material with gold for decorative work are either the mechanica process of covering with gold leaf or the process of electro-gilding. In this latter, advantage is taken of the tendency of gold to form soluble double compounds with alkaline cyanides, which in the presence of air apparently dissolve the metal according to the equation :—

$$Au_2 + 4KCN + O + H_2O =$$
$$2(AuCN.KCN) + 2KOH.$$

The material to be gilt is connected with the zinc terminal of a galvanic battery, and dipped in a bath containing the above gold compound, whilst there is also placed in the same bath a slip of gold attached to the copper end of the battery. This gradually dissolves, replacing the gold abstracted from the bath by the electro-gilding.

Besides the protective action which gold-leaf exercises in decorative work, the very thin films of the metal display some interesting properties in regard to colour, according as they are viewed by direct or by transmitted light. Thin gold leaves allow light to pass through them, appearing green or blue when held up to the light, although exhibiting the ordinary gold colour by reflected light. If such a gold leaf is spread upon a glass surface and heated for some time to nearly the boiling point of oil, it becomes nearly transparent by transmitted light, but still shows the gold colour by reflected light; if pressed by a moderately hard surface, it will again transmit a green light.

From the great brilliancy of the colours which gold shows when reduced from its salts in a fine state of division, it has been largely used in decorative work for imparting ruby colours to glass and porcelain ware. The colour, "Purple of Cassius," is a compound of gold, tin, and oxygen, obtained by the addition of stannous chloride to a mixture of stannic and gold chlorides. (Experiment 11.)

Having now considered the properties of the common metals and some of their compounds, as selected in our first lecture, it only remains for us to examine, from a general point of view, the various actions which tend to interfere with their permanency as structural materials, and certain methods which may be adopted for their preservation.

The circumstances most commonly affecting the permanency of metals are:—exposure to the action of noxious or acid vapours found in districts near large manufacturing towns; the action of oxygen more especially in the presence of moisture; and the action of carbon dioxide in presence of moisture, air, and organic acids derived from the soil or otherwise.

Of all the gaseous acid impurities, those of sulphur vapour and its oxidised products, sulphurous and sulphuric acids, together with hydrochloric acid vapours, are perhaps the most commonly met with in regard to deteriorating actions on exposed metals. Sulphur itself, in a manner similar to oxygen, has a strong attraction for metals, although unlike that latter element, its action is seldom exercised till a rise in temperature takes place. Thus copper or iron remain, to all appearance, unacted on when in contact with solid sulphur, even when intimately mixed; but both readily combine with that substance at high temperatures when it is converted into vapour. (Experiment 12.)

The action of sulphur compounds on metals, producing as it does, under certain conditions not only an actual corrosion of the metal, but in many cases a blackening action due to the deposits of sulphide; it becomes interesting to examine the chemical questions involved in some of these reactions, not only from a structural, but also from a decorative point of view.

All the common metals form either directly when heated with sulphur, or indirectly when brought in contact with its hydrogen compound, a series of compounds *sulphides* generally of a dark colour; but their methods of formation and properties are very different. To study their properties, the most convenient method for their formation is to pass a current of the gas sulphuretted hydrogen through a series of vessels containing solutions of the salts of the several metals. (Experiment 13). The metals selected are copper, lead, cadmium, antimony, iron and zinc, all at first being in an acidified solution. On passing the gas you will observe that the behaviour of the solutions is different, the copper and lead yielding black sulphides, the cadmium bright yellow, the antimony orange, and, at present, the iron and zinc no sulphide. We see here at once not only the difference in colour of the different sulphides, but also the fact that they are not all obtainable from acid solutions; in fact, that some, like lead and copper, yield sulphides insoluble in acids, and consequently much stronger in their nature, and probably when once formed, more difficult of removal. Taking, however, the salts of iron and zinc previously saturated with the sulphur gas, and neutralising the effect of the acid by means of an alkaline solution, we see that as soon as neutralisation takes place, we obtain from the iron a black, and from the zinc a white sulphide, these two last metals thus yielding sulphides soluble in mineral acids, but insoluble in alkaline solutions.

The fact that zinc yields a white sulphide is important to the decorator, as, by employing the oxide, or zinc white in his work, no change in colour of his pigment will take place, even in the presence of sulphur vapours, as the resulting compound is still white. This, unfortunately, is not the case in regard to silver, which is one of the metals capable of uniting directly with sulphur vapours at the ordinary temperature, becoming tarnished even with the mere exposure to the ordinary town atmosphere; a tarnishing which can only be removed by either mechanical rubbing, or some solvent means, consequently entailing considerable loss of the valuable metal when cleaning it.

The action of sulphur compounds upon lead is very marked, but its disadvantage is more particularly felt in connection with the use of its compounds as pigments. Although apparently possessing, more than other substances, the advantage of saponifying with oils, and thus giving what is technically known as *body* to colours, the white-lead pigments become easily coloured by the formation of thin films of sulphide. (Experiment 14.) Here, however, we find a difference between the lead and silver compounds in the fact that the lead sulphide will undergo oxidation into the white sulphate on the application of oxidising agents, such as hydrogen peroxide; and although by this action the original lead compound may be weakened, it is replaced by a white coloured substance not much inferior as a pigment to the white lead. (Experiment 15.)

The ability of lead to withstand the action of acids has already been alluded to, and so far as mineral acids are concerned that metal and copper, undergo little or no change under the ordinary circumstances to which they are exposed.

The action of acid vapours, however, on such metals as iron and zinc is very different, taking place with considerable activity when the metals are in the form of thin or perforated sheets and gauze. I had occasion myself to observe the action of the air of Glasgow on a window blind of fine iron wire-gauze during a period of about seven years. Although originally protected with lacquer, the lower portion of the blind in position opposite to where the window had been daily raised from its sash, had been gradually eaten away. There is no doubt that such corrosive actions are assisted by the simultaneous process of oxidation, but there is, at the same time, evidence of the direct action of the acid vapours.

The circumstances promoting such action are impurities in the metal itself, and, as we have already seen, the close contact of two different metals producing a galvanic couple in the presence of moisture. The corrosion which takes place on the bottom of iron railings set in stonework with melted lead, is largely due to galvanic action, and the same action will exercise its influence in all cases where two different metals come in contact, unless that contact be as perfect as possible. From experiments, however which I have shown you, it is at once evident that some protection may be obtained from observing the electrical properties of the different metals, and so bringing the proper ones in contact. Thus, as we have seen in the experiments with zinced iron, small imperfections may to a certain extent be disregarded, as if any action takes place it will probably be confined to the more electro-positive zinc, and the iron thus becomes protected till the whol of the zinc is destroyed.

In dealing with questions of corrosion c metals there can be little doubt that thi action depends, in the circumstances unde which the metals are usually placed, just a much to the process of oxidation as to th direct corroding by the acid vapours.

This is especially the case in the deterioration of iron by rusting, where heat is produced in the oxidation of the metal, and where th rust when formed exercises no protective influence on the iron but rather tends to increas the corrosion. From the chemical decompositions relating to the action of air and moisture in the presence of carbon dioxide which were discussed at an earlier period o the course,

$$Fe + H_2O + CO_2 = FeCO_3 + H_2,$$

and

$$4FeCO_3 + 6H_2O + O_2 = 2Fe_2(OH)_6 + 4CO_2$$

it is evident that a comparatively small amoun of carbon dioxide may effect the indirect oxidation of a large quantity of iron. On examining the composition of rust it is found that i contains a small quantity of hydrated ferrous oxide as well as the hydrated ferric oxide, the former existing largely in the lower layers. The actual changes in the process of rusting are probably therefore during the process much more complicated than is expressed by the above equation.

From many experiments carried out by Crace Calvert he drew the following conclusions:— (*a*) In dry oxygen, no oxidation. (*b*) In damp oxygen, imperfect and intermittant oxidation (*c*) In dry carbon dioxide, no oxidation. (*d* In damp carbon dioxide, slight formation of ferrous carbonate. (*e*) In dry carbon dioxide and dry oxygen, no oxidation. (*f*) In damp carbon dioxide and damp oxygen, most rapid oxidation.

The rusting of grey cast-iron is apparently slower than that of wrought-iron, the different varieties corroding more quickly as the amount of carbon increases in the iron.

As we have seen, copper is less easily oxidised than iron, but it does yield, to a certain extent, when exposed to moist air. In this case, the green film of basic carbonate already alluded to is formed. By the action of cupric salts on metallic copper cuprous salts are produced, and as these at once have the tendency to undergo oxidation they act as carriers of oxygen from the air to the copper during the action and so a kind of progressive corrosion may be set up. The presence of vapours of hydrochloric acid, or the contact of the copper with a solution of salt in the presence of air will also produce a corrosive action, due to the formation of the oxychloride of copper.

The action of corrosive agents on copper alloys is much the same as on the metal itself, except in the cases of the copper and tin alloys, which are attacked less easily than the metal when alone. This is also the case in copper aluminium alloys, a circumstance which permits of their use for fittings, &c., which have to be placed in exposed conditions.

Zinc undergoes superficial oxidation in moist air, becoming covered with a coating of oxide and basic carbonate, which however acts as a preservative for the rest of the metal. In the presence of acid vapours or even solutions of certain chlorides, this metal undergoes rapid corrosion. When perfectly pure the metal will, in a great measure, withstand these actions, but the commercial zinc containing lead is easily acted on, as there is present in this case the elements of an electric couple.

The action of waters containing lime salts on zinc is very much the same as that of moist air, the metal becoming coated with a protecting deposit of mixed oxide and carbonate. Like lead, however, waters containing nitrates and organic matter, especially acids, act considerably on zinc, more especially when used as a coating on iron. This action is greatly due to the reduction of the nitrates into ammonia; zinc like aluminium, being soluble in alkaline solutions.

Lead also undergoes oxidation in the ordinary atmosphere, but like zinc oxidation is slight, and is controlled by the formation of a protective coating of oxide, so that under *ordinary conditions* lead may be regarded as a metal not likely to undergo much corrosion. As we have already seen, this is especially the case with acid vapours such as hydrochloric acid vapours, or even dilute sulphuric acid. The principal conditions under which lead fails are when it comes in contact with air, moisture and carbonic acid, more especially if organic acids derived from the soil or other sources are also present. In this case, rapid corrosion may be expected, the action being similar to that already mentioned in the formation of the basic carbonate, or white lead. This action being continuous in the presence of the chemical substances mentioned, the lead becomes finally entirely converted.

Tin may be regarded as a metal showing considerable resistance to oxidation or decay under ordinary circumstances, and from the non-action of vegetable acids upon it, it is particularly applicable as a coating for other metals when such fluids are present. Tin, as we have seen, is little used by itself, but generally alloyed with some other metal. It is therefore, probable that if corrosion takes place the action may be started, not in the tin, but in the foreign substance. In the employment of this metal, it is also to be remembered that under extreme cold tin apparently undergoes spontaneous disintegration into the grey or crystalline variety.

It will be readily understood that the mass in which the metal is exposed to corrosive action under ordinary conditions has much to do with the extent of that action. Thick sheets of iron and zinc will withstand the action more readily than thin perforated plates or material of the nature of wire gauze.

EXPERIMENTS ILLUSTRATING LECTURE III.

1. Same experiment as No. 12, Lecture I.

2. A piece of pure zinc is immersed in dilute sulphuric acid. A slip of silver or platinum is then allowed to sink through the acid till it touches the zinc, when it will be raised up again by the evolution of the hydrogen on its coming in contact with that metal.

3. A perfectly clean slip of iron is immersed for some minutes in a bath of melted zinc covered with ammonium chloride; on withdrawing the slip, it will be found coated with zinc.

4. A stick of solid zinc chloride is drawn over a heated and very slightly rusted sheet of iron. The cleaning effect of the zinc chloride is at once seen.

5. A zinc plate thoroughly cleaned by very dilute hydrochloric acid was amalgamated by pouring over it a stream of mercury.

6. Two slips of iron are taken; the one coated with tin the other with zinc. Small portions of the tin and of the zinc are scraped away from the iron and both are placed in different beakers containing dilute sulphuric acid. After a few seconds immersion the two solutions are tested with potassium ferrocyanide; in the case of the tinned iron a blue precipitate is at once obtained, showing that the iron is the metal first attacked; but in the case of the zinced iron a white precipitate of zinc ferrocyanide is obtained, showing that in this case the zinc is the metal first dissolved.

If the slip of zinced iron be left longer in the liquid, the zinc will be entirely dissolved, and a blue colour will be produced, due to the acid beginning to act upon the iron.

7. A sheet of partially oxidised copper is rubbed with a strong solution of zinc chloride, when it at once becomes bright from the destruction of the film of oxide. The use of borax as a cleansing material is also shown by heating a slip of partially oxidised copper, and then drawing over it while hot, lines with a pencil of fused borax; the copper becomes bright wherever the borax has touched it.

8. Aluminium foil is placed in flasks containing nitric acid, hydrochloric acid, and caustic potash. No action takes place in the case of the nitric acid, but the metal dissolves rapidly in the other two with the evolution of hydrogen.

9. Gold leaf and aluminium bronze are separately treated with nitric acid; the former remains unacted upon, the latter is at once dissolved with evolution of brown fumes.

10. Gold leaf is placed in separate beakers, strong hydrochloric acid is added to one and strong nitric to the other. The gold is not acted on by the acids when separate, but upon mixing them together it readily dissolves.

11. Stannous chloride is added to a solution of gold containing a small amount of stannic chloride, when a beautiful purple colour is obtained throughout the fluid, due to the precipitation of finely reduced gold. The beauty of the colour depends upon the accurate balancing of the proportions of stannic and stannous chloride.

12. Sulphur is heated in a flask till it melts and boils; a coil of copper wire is then introduced through the neck, when it at once begins to glow in the sulphur vapour, being converted into sulphide, which drops down into the melted sulphur.

13. A current of hydrogen sulphide is passed through wash bottles containing solutions of copper, lead, cadium, antimony, iron, and zinc, acidified with hydrochloric acid.

14. A sheet of cardboard painted with moist white lead is placed in a jar, into which hydrogen sulphide gas is passed in gradually increasing quantities. The white lead gradually turns first yellow, then brown, and finally black.

15. Hydrogen peroxide is brushed over a pattern previously formed on cardboard in lead sulphide. The pattern changes from black (PbS) to white ($PbSO_4$) when washed with the peroxide.

Miscellaneous.

GERMAN SUGAR INDUSTRY.

The export of German sugar in 1895 reached higher amount, namely 4,775,394 quintals (quintal = 220·4 lbs.) of raw sugar, and 4,153,947 quintals o refined sugar than had ever previously been attained The greater part of the exports were sent to Englan (6,158,000 quintals) where the consumption of suga per head of the population is three times greater tha it is in Germany. The exports to the United State experienced considerable fluctuations, owing to th numerous changes in the Customs' legislation. Afte the establishment of bounties in Germany, the exemp tion from duty which German sugar previousl enjoyed in the United States was abolished. I 1895 this country took 493,169 quintals of raw sugar and 115,140 quintals of refined. By order of import ance, Holland comes in the third place, principally fo raw sugars; but German exports of raw and refine sugar to this country vary also very considerably they fell from 745,150 quintals in 1894, to 411,65 quintals in 1895. The same fluctuation is observabl in German sugar consignments to Belgium, whic country formerly was an excellent market for Germa sugar, but which has now sunk to comparativ insignificance. In 1895, 3,480 quintals of refine sugar were sent there, as compared with 72,60 quintals ten years ago. Sweden supplies enoug of her own production for the needs of her hom consumption, and will soon begin to export sugar Duties established on the importation of foreig sugars have very considerably diminished Germa imports into that country, Norway, on the othe hand, is a far better market for Germany, which supplied it with 102,230 quintals in 1895, while Denmar took 83,630 quintals. Russia took in the same yea 78,090 quintals of German sugar. In Switzerland owing to the reduction in transport rates granted b the German railways, the exports of German suga have since 1893 much increased, while in Italy, wher the customs duties on imports have been increased the amount of German sugar received fell fro 256,080 quintals in 1892 to 41,750 quintals in 1895 Exports to Roumania have also shown a falling off Portugal took 30,500 quintals in 1895. A very noteworthy fact is the increase in 1895, in the shipment of sugar from Hamburg to the extreme East—th Indies and Japan. The latter country receive 90,300 quintals, which amount it is expected will b exceeded this year. In Africa, particularly at th Cape and in Morocco, the receipts of German suga do not yet exceed 17,000 quintals. To Canada th exports are about in the same proportion. Consignments to the South American States, with the exception of Chili, are of little importance, while to Australia they are falling off. It will be observed from the foregoing that the number of outlets for

Germany are becoming more and more restricted—Sweden, Belgium, Roumania, and Australia are gradually closing their ports to German imports. In other countries, such for example as Holland, Italy, and particularly the United States, the changes in Customs legislation make very uncertain markets of these countries, and this condition of affairs is not compensated for by the new outlets in the Indies and Japan. Germany actually exports 60 per cent. of her sugar production, chiefly owing to the requirements of the United Kingdom.

SALTED FRUITS.

The preservation of lemons, oranges, and citrons destined for export from Italy, and not for immediate consumption in their integrity, but which are nevertheless valuable articles of export on account of the various uses to which their juices may be applied, is a very important object in those cases where the shipment and conveyance to distant parts would be impossible, either on account of the distance to be traversed, or on account of the unsoundness of the fruit, or from both causes combined. It is customary in Italy to slice and steep the fruit in large casks filled with salt and brine. The bitter oranges, lemons, or citrons are then first of all examined, and Vice-Consul Pignatorre, of Messina, says that although not subjected to the same crucial tests which would be required were the fruit to be shipped entire, or their essence properties considered, still they must not be internally diseased and must be of average juiciness to be exportable and marketable. They are then soaked in salt water for a few days, the time varying between three and eight days, according to the more or less maturity of the fruit. On the arrival of the fruit it is repeatedly washed in fresh water until the salt contained has been completely dissolved and carried off. It is, however, unquestionable that whatever the preserving qualities of the salt, the process involves an almost total loss of the essential oil of the peel, and a deterioration of the juice, and should only be resorted to in extreme cases, when the fruit would not be otherwise profitably used at home or shipped abroad.

THE CADIZ SHERRY TRADE.

The principal branch of commerce in which Cadiz is interested is the shipment of sherry. Although this wine takes its name from and is principally made in the town and district of Jerez de la Frontera, yet a very large quantity is made in the surrounding districts of Puerto Santa Maria, Sanlucar, and Trebujena. Consul Hearn, of Cadiz, says that for some years past the sherry trade has been somewhat under the cloud, which, either from fashion and taste, or other outside causes, appears periodically to cast its shadow over one class of wine or the other. Possibly the importation some years ago of cheap foreign spirit, with which unscrupulous dealers were enabled to fortify wines of inferior quality and export them for sale at low figures, may have been the reason for this; but now that the importation of foreign spirit is prohibited, and it cannot pay to use anything but pure grape spirit for strengthening the wines, which, unless so treated, could not bear exportation, there can be no reason for doubting the purity of sherry, always remembering that the cheapest liquid in Spain, hardly excepting pure water, is the juice of the grape, and the cheapest spirit is that made from it. As regards the process of sherry making, about a ton of freshly gathered grapes is placed in each wine press, and dusted over with gypsum, in order, it is believed, to absorb the dew on the grapes, and also to neutralise some of the acids in the fruit. The grapes are then trodden down by men in leather shoes, and the juice is run off into butts. The mash is afterwards pressed again by mechanical process, and the juice thus extracted is used for distillation. The juice in the butts is left to foment and fall bright for five or six months, when it is racked from the lees, *i.e.*, drawn off clear into other butts. The lees are dried in the sun and then exported to France, where they are used for the extraction of tartaric acid. The young sherry has a peculiarity which is believed to be unknown in other wines, and that is the formation during its early youth of cream of tartar, or *flor de vino*, on the surface, which gradually sinks to the bottom and mixes with the lees. Wines which breed much *flor de vino* become *Finos* or *Amontillados*, while those which do not breed, or breed very little, cream of tartar, turn into the richer, fuller-bodied wines known as *Oloroso*. From the same pressing of grapes from the same vineyard, some of the butts will turn out to be *Fino* and some *Oloroso*. When the wine is racked from the lees, it has a small amount of grape spirit added to it—about two gallons to a butt of 112 gallons—more or less according to the quality, vintage wines requiring no added spirits at all. The butts are then arranged in the bodegas or wine stores, and are kept up to a uniform standard by the solera system, which consists of filling up the older butts as the wine is drawn off, by younger wine of a similar character, so that the various soleras always retain their distinctive character, and consumers are able to get repeatedly, without doctoring or adulturation, the exact class of wine they prefer, or have been accustomed to. It is unfortunate, says Consul Hearn, that English sherry drinkers have not generally acquired a taste for the soft, dry, delicate flavour of the sherries as they lie in the bodegas as nature made them, for there is no doubt that they then are in the most perfect and delicious state. To meet the English taste, many of the wines have to be altered in character, some have to be sweetened with the wine called Pedro Jiminez, made from grapes left on the ground to ripen, and almost entirely used for sweetening and colouring purposes, while others on account of their nature have to be fortified with spirit in order that they may bear transportation to other climates. However much sherry has to be prepared to meet certain tastes and demands, there is at any rate among the principal grocers and shippers, no adulteration of the wines at all, but they are usually mixed and blended so as to suit the public taste, except in the case of the very best vintage wines. Of such merit is old sherry, that Spanish doctors recommond the Oloroso for the use of their patients as being far more strengthening and much more wholesome than all reputed invalid wines. The taste for sherry has of late years greatly grown in the United States, and the exportation to that country is largely on the increase. The amount of sherry shipped from Cadiz in 1894 was 49,695 butts, and in 1895, 52,431 butts. In 1895, there were 88 export firms engaged in the sherry trade at Jerez, among those doing the largest amount of business being 12 English firms, and the British capital involved must amount to a very large sum of money. The sherry in stock at Jerez probably amounts to about 500,000 butts, while some 50,000 butts are produced every year. The sherries from Jerez and Puerto Santa Maria are shipped from Cadiz, while the wines from San Lucar, Chipiona, and Trebujena are shipped from Bonanza and Seville.

General Notes.

Coffee in the Congo.—M. Laurent, Professor of the Agricultural Institute of Gembloux, entrusted by the independent State with a mission to the Congo, has just published a report upon the results of his travels, in which he says that the Congo will, in some years to come, be as important a coffee-growing country as Brazil is at the present time. The coffee tree will find in the great equatorial forest the conditions of soil and climate that are the best suited for it. It grows there in a wild state, and there are three descriptions known, two of which yield excellent results. According to the information M. Laurent has obtained at Bosoko and Coquilhatville, the preparations of the ground for coffee plantations would require native labour, which could be obtained at a cost of about £10 per hectare (2·47 acres).

Tobacco Cultivation in Turkey.—A sunny district, protected from wind is, says Consul Albert, of Constantinople, preferred for a tobacco plantation in Turkey. The slope of a hill towards the west is preferred. The seed is sown during the months of February and March, and the older the seed is, provided it is kept free from damp, the better the production will be. After the seed has been sown, sheep manure in powder is spread over it in small quantities. To protect the young plants from frost, they are covered over with mats supported on stakes. When the plants are 15 to 20 centimetres (5·9 to 7·9 inches) high, they are picked out and transplante half-a-yard distant one from the other in a field fr from stones, which has previously been ploughed least six times, and well manured with sheeps' dun After transplanting, the plants are watered only th first and second day.

"Perfilado," or Drawn Needlework, i Mexico.—What the black lace is to Malta, and th laces of Antwerp and Brussels are to Belgium, th "perfilado" needle, or drawn work, is to Mexico and, as in the former countries, women and girls ar occupied with this intricate and delicate work. Th United States Consul at Matamoros says that th city is the principal place of its production, and larg quantities of this work are annually exported to th United States. Some of it is very expensive, a yea being required to make a single piece. Table cloths bed covers, covers for tables, lounges, and chair require the longest time, and are most costly *Panuellos*, or handkerchiefs, are made either of sil or very fine linen. This work is all done wit needles, sometimes very fine needles and the fines spool thread. For a long time perfilado was mad an industrial feature in the public schools; every gir learned to make it. In this way, the art of makin this beautiful work was acquired, and others wer taught in the family, until nearly every girl an woman in Matamoros could either make it or assis in its production. It is hard and difficult work, from which the earnings are very small, often not mor than seven pence a day. The linen or silk is placed in a frame, the threads are drawn out one way, and with a needle the design is worked. The work is kept marvellously clean.

Production of Amber. — The working of amber in Prussia is a monopoly in the hands of a firm who own the two best mines, Palmnicken and Kraxtepelle. For the concession they have, according to Consul Hunt, of Dantzig, to pay to the German Government a royalty of 650,000 marks (about £32,500) a year. It is reckoned that this firm has up to now paid no less a sum than £1,000,000 in royalties to the German Government. In addition to the output from the mines in 1895, a good deal of amber was picked up on the beach at Pillau, in the province of East Prussia, being washed up with the seaweed during the prevalence of north-westerly gales. The shore at Pillau after a storm is sometimes covered with a layer of seaweed three feet thick, amongst which the amber is found entangled. Men, women and children find easy and lucrative employment in searching for the amber along this part of the amber coast. The people engaged in this precarious work often earn thirty shillings a day and more. In 1895, about 100 tons of raw amber came to Dantzig to be worked up, as compared with 140 tons in 1894. It was nearly all melted to make lac and varnish. The larger pieces are made into beads, which are sent all over the world. The beads known to the trade as Leghorn corals were in strong demand.

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FRIDAY, NOVEMBER 6, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-third Session will be held on Wednesday evening, the 18th of November, when the Opening Address will be delivered by MAJOR-GENERAL SIR OWEN TUDOR BURNE, K.C.S.I., C.I.E., Chairman of the Council. The subject of the Address will be "India: its Arts, Manufactures, and Commerce."

Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

NOVEMBER 18.—Opening Address by MAJOR-GENERAL SIR OWEN TUDOR BURNE, K.C.S.I., C.I.E., Chairman of the Council.

NOVEMBER 25.—"Recent Developments in Mechanical Road Carriages." By W. WORBY BEAUMONT, M.Inst.C.E.

DECEMBER 2.—"The Teaching of Economics." By W. A. S. HEWINS, M.A.

DECEMBER 9.—"Mining at Great Depths." By BENNETT H. BROUGH, Assoc.R.S.M.

DECEMBER 16.—"The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the original Instruments for which it was written.) By ARNOLD DOLMETSCH.

Papers for meetings after Christmas:—

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Light Railways." By EVERARD R. CALTHROP.

"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

"Lithography as a Mode of Artistic Expression." By LEO MCCULLOCH.

"The Artistic Treatment of Heraldry." By W. H. ST. JOHN HOPE, M.A.

"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"The Chemistry of Tea." By DAVID COOK.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock:—

January 21, February 11, March 11, April 1, 29, May 20.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock:—

January 19, February 16, March 16, April 6, May 4, 25.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 26, February 9, March 2, 30, April 27, May 11.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

PROF. VIVIAN B. LEWES, "The Use of Gas for Domestic Lighting." Three Lectures.

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.
January 18, 25, February 1, 8.

C. F. CROSS, F.C.S., "The Industrial Uses of Cellulose." Three Lectures.
February 15, 22, March 1.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.
March 15, 22, 29, April 5.

LEWIS FOREMAN DAY, "The Decorative Use of Lettering." Four Lectures.
May 3, 10, 17, 24.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Thursday Evenings, at Eight o'clock:—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.
January 28, February 4, 11, 18, 25, March 4.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 6th and 13th of January, at Seven p.m., by CLINTON T. DENT, F.R.C.S., Past-President of the Alpine Club, on "The Growth and Demolition of Mountains."

MULREADY PRIZE.

The Department of Science and Art having sent in two names of students of the Schools of Art in the United Kingdom as equal in merit in the National Competition, the Council have divided the prize, and awarded £10 and a silver medal to each of these students, viz. :—

Arthur A. Dixon, Holloway School of Art, and William N. M. Orpen, Dublin Metropolitan School of Art.

The Society's Prize was offered under the following conditions to the student who obtained the highest awards in the following subjects:—

A finished drawing of imperial size from the nude living model; a set of time studies from the nude living model (mounted on imperial size mounts); a set of studies of hands and feet from the living model (mounted on imperial size mounts); drawing from the life, done at the Examination on May 2, 1896.

No student was eligible for the award who did not pass in the Examination in drawing from the life, and who did not obtain an award for the finished drawing of imperial size from the nude living model. The other two subjects were optional. The works were those of the previous school year.

The drawings, &c., were submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1896.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of the Section was held on Thursday, 24th October. Present: Sir Charles M. Kennedy, K.C.M.G., C.B., in the chair, Mr. Francis Cobb and Sir Westby Perceval, K.C.M.G.; with Mr. Henry B. Wheatley, Assistant-Secretary to the Society, and Mr. Edward Cunliffe-Owen, C.M.G., Secretary to the Section.

The programme was discussed, and it was decided that arrangements should be made for a series of papers to be given descriptive of the progress of the British Colonies during the past sixty years of her Majesty's reign. The first meeting will be held on Tuesday, January 19th, when an introductory address will be delivered by the Right Hon. Sir Charles Dilke, Bart., M.P.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors shall send in descriptions of their inventions not later than the 31st December, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

THE EARLY HISTORY OF THE 1851 EXHIBITION.

[Some progress has been made with the preparation of the History of the Society, suggested by Sir John Donnelly in the address which he delivered at the opening of the Session 1894-5. The chapter dealing with the early history of the 1851 Exhibition seems sufficiently complete in itself, and of sufficient interest to justify separate publication in advance of the issue of the whole work. It is probable that other chapters of the history may lend themselves to similar treatment, and that it may be advantageous to publish them as they are written, since the finished book cannot be properly completed for some time to come.]

Probably the most important piece of work ever undertaken by the Society of Arts was the foundation of the Great Exhibition of 1851, and through it of that long series of international exhibitions which have had such far-reaching influences on the arts, as well as on industry and trade.

In the history, therefore, of the Society of Arts, the chapter dealing with its connexion with exhibitions is a very important chapter, and it therefore becomes necessary to set forth in some detail an account of the steps which led to the successful inauguration of the Great Palace of Industry in Hyde-park. Now that so many exhibitions have been held, and that experience has established a system—even a routine — for their management, we may easily overlook the difficulties which surrounded the path of those who started—without example or experience to guide them—so novel an experiment, and who, indeed, realised a success not surpassed by any of their followers. Some of these men are now forgotten. Others never received their due share of credit. Perhaps, now that all of them have passed away, it may be possible to set out without invidious comparisons their various shares in the great enterprise so far as the records of the Society enable it to be done.

As it was only with the initiation of the undertaking that the Society was concerned, so it will be only the early steps of preparation that will be recorded here. So soon as success was assured, and national support was certain, it was decided that so important a movement should be under Government control. Probably in no other way than by means of a Royal Commission could the great enterprise have been so successfully accomplished. Still the historian of the Society of Arts may be pardoned a regret that the Society should not have been able to carry out to the end the scheme it had carried so far, and reap the full reward of its early and devoted labours.

The question of the origin of national and international exhibitions has often been discussed, and there seems no doubt but that the earliest industrial exhibition of which there is any record was the Exhibition, held by the Society of Arts in 1761, of Agricultural and other Machines, for which the Society had offered prizes. Thus it may certainly be claimed for the Society that it initiated the idea of Industrial, as well as of Fine Art exhibitions.

The idea was also independently originated in France. In 1797, in the time of the Directory, an exhibition of French manufactures was organised in the then dismantled Château of St. Cloud. The execution of the scheme was, however, interrupted by the decree for the expulsion of the nobility, and the consequent enforced sudden flight of the originator—the Marquis d'Avèze, who was then commissioner for the State manufactures, Gobelins, Sèvres, &c., and had proposed the exhibition as a means of raising these works from the state of decay into which they had lapsed.*

In the following year the scheme was actually carried into effect in a temporary building on the Champ de Mars. This was the first of a series of French national exhibitions, the last of which was held in 1849. The success of these national shows was avowedly one of the causes which led to the promotion of similar exhibitions in this country.

Such an attempt was made in 1828. An influential committee was formed, with the Hon. G. Agar Ellis as chairman, and King George the Fourth gave his patronage. The Committee proposed to hold a series of annual exhibitions "of new and improved productions of our artisans and manufacturers." The site fixed upon was the King's-mews, which was pulled down in 1833, and stood on the site of the National Gallery. The scheme was well thought out, but seems to have been in advance of its time, for the manufacturers of the country did little to support it. The "National Repository," as it was termed, was continued for four years; in 1833 it was moved from the King's-mews to a house in Leicester-square, and after this it was discontinued.†

In November, 1844, Mr. Francis Whishaw, then Secretary of the Society, started a scheme for an annual exhibition of the products of national industry, and inserted advertisements in the *Times*, *Athenæum*, and other papers, offering prizes to the amount of £300. In this scheme Mr. Whishaw had the assistance of Mr. Joseph Woods; it came to very little, for the public gave it but slight support. A small exhibition of works of art and mechanical inventions was however held in the Society's rooms on the 6th December, 1844, and a similar one on the 28th January, 1845. So far as it appears from any remaining records, these little exhibitions were held for a single evening each, but they deserve notice as being really the first sign of the movement which eventually led to the Great Exhibition. Mr. Whishaw states, in a memorandum he left on the subject, that, in 1844, he had an interview with Mr. Anson, Prince Albert's private secretary, and that he had asked for the Prince's patronage, apparently without any result.

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* A full account of this first French exhibition, and of its successors, will be found in the Report on the 1849 Exhibition, prepared by Mr. Digby Wyatt for the Council of the Society.

† A full account of this exhibition is given in Mr. Hollingshead's introduction to the official illustrated catalogue of the 1862 Exhibition.

Mention should also be made of the triennial exhibitions of the Royal Dublin Society, held from 1827 to 1850; of an exhibition held in Covent-garden in 1845, of which, however, no complete record appears to have been preserved; and also of attempts by Mr. S. Richards to get up an exhibition of industry, including foreign manufactures, in Birmingham, in 1836.[*]

At a meeting of the Miscellaneous Matters Committee of the Society, held on the 21st of May, 1845, with Mr. Thomas Webster in the chair, Mr. William Fothergill Cooke, apparently at the instance of Mr. Whishaw, suggested that steps should be taken for the establishment of a national exhibition of the products of industry, and that efforts should be made to raise funds for the purpose, he himself offering to start a loan fund with the sum of £500. The matter was brought under the notice of H.R.H. Prince Albert, the President of the Society, in the address read to him at the distribution of the Society's rewards on the 2nd June in that year; and it is stated that His Royal Highnees then directed the matter to be brought again before him as soon as the plan for carrying the proposal into effect had attained a practical form. A Committee[†] was appointed for the purpose, and succeeded in obtaining the promise of a certain amount of funds Hyde-park was suggested as a suitable site and other plans were proposed. The committee even entered into communication with the owner of Baker-street Bazaar. However when they took steps to ascertain the view of manufacturers generally on the subject though many promised support, they did not meet with sufficient encouragement, and the proposal for a general national exhibition was for the time allowed to drop.

But the idea was not allowed entirely to perish. Steps were taken by those who directed the Society's action to prepare the public mind for a great national exhibition H.R.H. the Prince Consort had, since his election as President, continuously impressed on the Society the necessity of its taking steps to improve the condition of the artistic industries of the country, then in a very backward condition, and had urged on the Society, as its proper work, the encouragement of the application of art to practical purposes. As a means to this end, the Council were induced—at the original suggestion, it is believed, of Mr. Scott Russell, who was then associated with Mr. Whishaw as secretary,[*] and succeeded him in the following March—to offer prizes for improved designs o "useful objects calculated to improve genera taste." A fund for the purpose was subscribed and a first offer of prizes was made in the year 1846. The response was meagre, but among the articles sent in was a tea-service designed by Mr. (afterwards Sir) Henry Cole (under his well-known pseudonym of Felix Summerly) and manufactured at his instance by Messrs Minton. This service was simple in form and colour, excellent in shape and thoroughly artistic in design. It afforded an admirable example of the true principles which should be followed in the manufacture of articles of common daily use, and, indeed, it effected a revolution in that manufacture. From Felix Summerly's tea-cup sprang, not only the 1851 Exhibition, but that application of art to industry which has changed the whole character of those manufactures to which artistic principles are applicable. It was, indeed, the commencement of the present school of art-workmanship in this country.

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[*] Local exhibitions were held at Vienna, 1839; Berlin, 1844; Hanover, 1835; Munich, 1818; Lausanne, 1839; Brussels, 1835; and at many other places on the Continent. A list of these is given in the Introduction to the British Catalogue for the Philadelphia Exhibition, 1876.

[†] This Committee consisted of W. F. Cooke (well known iu connection with the establishment of the electric telegraph; d. 1879); Joseph Woods, G. T. Kemp, Alfred Ainger, J. Scott Russell (then a member of the Miscellaneous Matters Committee, afterwards secretary; d. 1882), Thomas Webster (Q.C. The eminent patent lawyer, father of Sir R. Webster, Attorney-General; d. 1875), Thomas Winkworth (partner in the firm of Winkworth and Proctor, silk brokers; an active member of the Society d. 1865), Francis Fuller, Bennett Woodcroft (F.R.S., Professor of Machinery at University College, London; clerk to the Commissioners of Patents; d. 1879), Thomas Sopwith (F.R S., Civil and Mining Engineer; d. 1879), and Mr. Francis Whishaw (d. 1858), as Secretary.

[*] At the first meeting of the Council, 6th December, 1845, a sum of 50 guineas was offered "through the Secretary" for prizes. It appears that the offer came from Mr. Scott Russell himself.

In the following year (1847) the offer of prizes was renewed, and the prize articles of 1846, together with the articles sent in competition in 1847, formed the basis of the Society of Arts' first Exhibition of "Select Specimens of British Manufactures and Decorative Art" opened at the Society's House in March, 1847. The Exhibition itself would have been a poor one had it not been supplemented by examples lent, at the urgent solicitation of certain members of the Society,* by some of our leading manufacturers. In the event it turned out a complete success, and was visited by 20,000 people.

Still greater success attended a repetition of the experiment in 1848, for this second exhibition was attended by over 73,000 visitors, and for the third, in 1849, the accommodation on the Society's premises proved quite inadequate.

By these art-workmanship exhibitions the intended object was fulfilled, of demonstrating to the public the value of a similar undertaking on a larger scale; but they were continued for some time in various forms. In 1850 there was an exhibition of works of ancient and mediæval art,† and in 1848 one of models of modern machinery and inventions. This was the first of a series which was held annually till 1861. Two exhibitions of pictures were also held about this time—one in 1848 of Mulready's works, and one of Etty's works in 1849. The object of these, which were held at the suggestion of Mr. H. Cole, was to raise funds in aid of the establishment of a gallery of British art; but, as they were not successful in this respect, the idea was abandoned.‡ It does not appear that they were associated with the Great Exhibition movement, or that they had any influence upon it.*

The next definite step taken by the Council of the Society was to send, in March, 1848, a deputation to the President of the Board of Trade, Mr. Labouchere (afterwards Lord Taunton), suggesting that the articles shown at the Society of Arts annual exhibitions should be circulated amongst the provincial Schools of Design, then under the Board of Trade.† The memorial presented by the deputation (which bears on the face of it evident signs that it was the work of Mr. Henry Cole) further proposed that every fourth year the Society should make a collected exhibition of the principal objects, and others specially prepared, in a suitable building in London; that the site for the building might be Trafalgar-square; that the Government should provide the building; and that the Society should have the management of the exhibition.

Mr. Labouchere approved of the proposal, and promised the assistance of the Schools of Design, but, on the question of site, referred the deputation to the Chairman of the Commission on Woods and Forests,‡ Lord Morpeth (afterwards Lord Carlisle). The same deputation waited on Lord Morpeth two months later (in May, 1848), and though he refused the use of Trafalgar-square, he offered the use of the quadrangle of Somerset-house.

The progress which had been made was duly reported by the Council to the Society in an address read on the occasion of the opening of the third Exhibition of British Manufactures in March, 1849. This address definitely stated that the annual exhibitions were "only parts of a series of displays which it is proposed shall culminate every fifth year in a great national exhibition, embracing all manufactures," and proposed 1851, the fifth year from the first of the Society's Exhibitions of Manufactures for the first national one. The address then went on to state what had been done by the deputation above mentioned, claimed that the Society had "practically demonstrated the means of establishing such exhibitions, and educated most successfully a numerous public of all classes of society to appreciate them and crowd to see them," and concluded by urging on Government that it should "provide, once in every fifth year, a suitable building, in which national exhibitions, duly representing the best productions in all branches of manufactures may be found."

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* Probably Mr. Henry Cole and Mr. Scott Russell. Their names do not seem to have been recorded.

† This—the first of its kind—was an exhibition of considerable interest. Collectors, who had not then the numerous applications for loans to which they are now subjected, were liberal, and generously lent many objects of interest and value. Mr. A. Wollaston Franks (now Sir A. Wollaston Franks, K.C.B.) acted as honorary secretary.

‡ The idea was, that with the funds resulting from the exhibition of each artist's works, a commission should be given him to paint a picture without restriction as to subject or size. From the Mulready Exhibition there was a small surplus, which was expended on the purchase of two of the artist's studies, and these were presented to the National Gallery. The Etty Exhibition resulted in a loss.

* The early history of the Exhibition is contained in a report prepared by Mr. Scott Russell, and read to a general meeting of the Society held on the 8th February, 1850. A great deal of information about these preliminary steps is given in Sir Henry Cole's "Fifty Years of Public Life." The introduction to the official illustrated catalogue of the 1862 Exhibition, prepared by Mr. John Hollingshead, contains an account of the origin of the Exhibition, mainly founded on Mr. Scott Russell's report. Mr. Scott Russell also made an interesting collection of documents on the subject, which, after his death, was purchased by the Society, and is now in its possession. The First Report of the 1851 Commissioners gives only a very summary account of these early proceedings.

† The members of the deputation were:—Sir J. P. Boileau, Bart. (a well-known archæologist and an active Vice-President of the Society; he died 1869), Mr. G. Bailey (Curator of the Soane Museum), Mr. Henry Cole (afterwards Sir H. Cole, K.C.B.), Mr. P. Le Neve Foster (at that time one of the Society's Treasurers), Mr. J. S. Lefevre, Assistant Secretary of the Board of Trade (afterwards Sir John Shaw Lefevre), and Mr. J. Scott Russell.

‡ The duties now discharged by the Office of Works then belonged to this department.

A little later in the same year—in April, 1849—a petition from the Council, which had been drafted by Mr. Henry Cole, was presented by Mr. Milner Gibson to the House of Commons. This petition was referred to the Select Committee on the Schools of Design, which reported on it favourably, thinking that there was "every reasonable probability that a National Exhibition of Decorative Manufactures, if properly organised, might be made to a considerable extent, if not wholly, to repay its expenses." The Committee also thought that the prayer of the petition was well worthy of the consideration of the Government.

In the previous year, 1848, Mr. Cole had submitted to Prince Albert, through his secretary, Colonel Phipps, the memorial afterwards presented to the Board of Trade, but its reception was not encouraging. Colonel Phipps stated that the Prince's opinion was not favourable to the plan, and that "no reasonable hope could be entertained of any co-operation or assistance, at any rate at present, from the Government." The time, however, had now arrived when the Prince was induced to take a different view of the proposal, and by lending it the support of his great influence, to carry it the success it eventually attained.

Careful study of the original records only serves to confirm the popular idea that the success of the Great Exhibition of 1851 was due to the wisdom and energy of the Prince Consort. Had he given but a nominal support it would doubtless, indeed, have been carried to a successful issue, but it would have been on a much smaller scale; probably it would have been confined to national products alone; and, while it would certainly have had useful and important results, it could never have had the effect it certainly did exercise on the arts, industries, and commerce of the world.

As previously mentioned, an exhibition o French Industry was being held in 1849 i Paris. This was visited by Mr. Henry Cole i company of Mr. Digby Wyatt, who had bee commissioned by the Society to prepare report on the exhibition,* and also by Mr Francis Fuller,† a member of the Council o the Society. Mr. Fuller, on his return, wrot to Mr. Scott Russell that, in his opinion, i would be possible to get up in London a much better exhibition than the one in Paris. On hi way back to London, as Mr. Fuller stated at a later period, he accidentally met at Southampton Mr. Thomas Cubitt,‡ who was then engaged on the building at Osborne. Two days later, on the 14th of June, when Mr. Cubit returned to Osborne, he mentioned the idea to the Prince, who is said to have expressed sympathy with the project. The matter, however was more formally brought to His Royal Highness's notice, first privately, by Mr. Scott Russell, and then publicly, in the report of the Council, read at the annual presentation of the prizes on the 14th June in that year. From the minutes of the meeting, which are somewhat meagre, it does not appear that Prince Albert expressed any views of his own on that occasion, but he shortly aftewards sent for Mr. Scott Russell, and obtained from him full information as to the scheme. He also sent for Mr. Cole, on the occasion of a visit paid by him to Colonel Phipps, and questioned him about the arrangements for the proposed exhibition. It was evident that His Royal Highness's interest had been thoroughly aroused, for on both occasions he went fully into the matter, and gave his own opinions as to the best means of success. He suggested Leicester-square as a suitable site, and, in answer to a question from Mr. Cole as to whether the exhibition should be national or international, he decided that it ought to embrace foreign productions, and must be certainly international. On Mr. Cole suggesting that, in that case, Leicester-square might not be large enough, and proposing, in reply to a further question, a site in Hyde-park, he was directed by the Prince to visit the park, and to consider whether a suitable site could be found.

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* Published the same year for the Society. A copy is in the Society's library. Sir Matthew Digby Wyatt died in 1877.

† Francis Fuller was a member of the Society from 1843 till his death in 1887. He, as will be seen, took a very energetic part in the preparations for the Exhibition. For some time he was managing director of the Sydenham Crystal Palace.

‡ The founder of the great firm of builders of which he and his brother William were partners. He died in 1855.

These informal discussions were preliminary to a more formal meeting, when the Prince summoned Mr. Scott Russell, Mr. Francis Fuller, Mr. Henry Cole, and Mr. Thomas Cubitt to attend at Buckingham Palace. A formal minute of the proceedings of this meeting was prepared, at the Prince's desire, by Mr. Scott Russell, and the original MS. of this minute, with the Prince's own corrections, is amongst the documents before referred to as having been collected by Mr. Scott Russell. Sir Henry Cole reproduced in *facsimile* in his autobiography the passage in which it was laid down that the exhibition was to be international. In the Prince's own words, it was considered "that whilst it appears an error to fix any limitation to the productions of machinery, science, and taste, which are of no country, but belong, as a whole to the civilised world, particular advantage to British industry might be derived from placing it in fair competition with that of other nations." At this meeting, also, Prince Albert suggested that the exhibition should include the four following divisions:—Raw materials, machinery and mechanical inventions, manufactures, sculpture and plastic art. It will be seen, therefore, that it was at this meeting that the various proposals for the holding of the Great Exhibition in 1851 at last took definite form, and here, it may be said, that the Great Exhibition really originated.

A second similar meeting was held at Osborne, which was attended by Mr. Scott Russell, Mr. Henry Cole, and Mr. Fuller, Mr. Labouchere, President of the Board of Trade, attending also, by desire of the Prince

At this meeting a definite plan for the exhibition was decided upon. It was settled that an exhibition should be held in London in 1851, under the presidency of Prince Albert, of works of art and industry of all nations; that there should be a Royal Commission to control and regulate the exhibition, and to deal with the question of prizes; that the Society of Arts should undertake to collect funds for prizes, and all the other exhibition expenses, and should provide for the holding of similar exhibitions quinquennially.

It was also decided that steps should be taken to ascertain the feelings of manufacturers, and to obtain their support.*

In order to carry these suggestions into effect, the Prince authorised Mr. Cole and Mr. Fuller to visit the principal provincial centres of industry, and to hold public meetings for the purpose of awakening interest and obtaining promises of support for the proposed exhibition. The costs of these journeys were, at all events in the first instance, defrayed by Mr. Fuller. The work of these gentlemen was supplemented by similar efforts by several other members of the Society, and the result was that a little later on in the year a report was presented to the Prince, showing that the proposal had met with warm support in all parts of the country.

In the meantime the matter had been brought before the Council of the Society, which was summoned on the 26th July, 1849,* to hear a report from the secretary of the meeting at Buckingham-palace on June 30th, and to consider what the action of the Society should be. The conclusion arrived at was that the resources of the Society were not such as to justify the Council in guaranteeing the necessary preliminary outlay, but that it might be possible to find some capitalists who would provide the necessary funds, provided they were allowed to make the exhibition, to some extent, a source of pecuniary profit.

The total probable cost of the exhibition was naturally a subject of considerable discussion. It was estimated by Mr. Cubitt that the cost of the building would not be much less than £50,000; £20,000 was proposed for prizes, and thus, with preliminary expenses, it was considered that £75,000 would be required to ensure success. To recoup this expenditure the following sources were relied upon—receipts at the doors, payments from exhibitors for their stalls, and various other miscellaneous sources of revenue.

For a long time great difficulty was experienced in finding anybody who would undertake the speculation. The matter was laid before numerous contractors, but without success, until at last Mr. Fuller, through the agency of his father-in-law, Mr. George Drew, of Guildford, succeeded in inducing Messrs. J. and G. Munday to undertake the risk.

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* Mr. Fuller, in an account of the meeting, published at a later date, states that Sir Robert Peel was also present, and that he expressed the opinion that the project was good and deserved support, but that until a sufficient majority of the manufacturers of the United Kingdom should declare in favour of it, he strongly advised His Royal Highness to have nothing to do with it.

* At this meeting Mr. Thomas Winkworth was in the chair, and there were present Messrs. Le Neve Foster, S. Hickson (d. 1870), S. Redgrave (d. 1876), F. Whishaw, and J. Scott Russell (secretary).

Messrs. Munday agreed to advance the sum suggested for a prize fund—£20,000—to the Treasurer of the Society, to be placed in the name of Prince Albert or of trustees appointed by him. They also undertook the whole cost of erecting the necessary buildings, and to provide the money for preliminary expenses. From the exhibition receipts they were to receive 5 per cent. interest on money advanced, and of the surplus profits one-third was to be paid by the Society of Arts to form a fund available for future exhibitions, while the remaining two-thirds were to go to the contractors, after payment of all costs of the exhibition.

To carry on the work the Council appointed an executive committee and three treasurers.* When the deeds of contract came up for approval, some of the members of the Council were of opinion that provision ought to be made in case the Government eventually consented to take over the management of the exhibition, and by agreement with the contractors a clause was inserted, empowering the Society, in the case of the above contingency arising, to annul the contract on terms to be settled by arbitration.

In the meantime steps had been taken for the appointment of the Royal Commission, which had been decided upon as necessary at Osborne on the 14th July. At the end of that same month the Prince had written to Sir George Grey, the Home Secretary, asking, as President of the Society, for the appointment of a Royal Commission, and had received from him an encouraging reply. The Commission was published in the *Gazette* for the 3rd January, 1850.† Besides the Commissioners, it appointed four treasurers for the receipts. The three gentlemen above mentioned who had been appointed treasurers by the Society of Arts, were named as treasurers for the payment of the executive expenses, and the same executive committee was nominated as had been appointed by the Council of the Society of Arts.‡ Mr. John Scott Russell and Mr. Stafford Henry Northcote (afterwards Stafford Northcote, and later Earl of Idd leigh) were appointed secretaries to the Co mission.

The first step taken by the Commission the 11th June, 1850, was to terminate the co tract which had been made with Mess Munday. It was thought, as the experime was of a national character, it ought to re upon voluntary subscriptions, and should n be made a question of profit and loss. T proposal was met in the most liberal spirit the Messrs. Munday, who accepted an awa made by Mr. Robert Stephenson, of £5,12 with costs of £587.*

On the 8th February, 1850, a special gener meeting of the Society of Arts was held hear a report by Mr. Scott Russell on t preliminary steps which had been taken. resolution approving the proceedings w passed, and the Society pledged itself support its President by every means in i power. It was also resolved that a subscri tion list should be opened, and a sum £7,888, out of a total of £67,896, was event ally contributed by the members.

The management of the exhibition w now, therefore, taken out of the hands of t Society, and the undertaking placed on a independent basis. The success achieved matter of history, but it is outside the histo of the Society of Arts.†

Miscellaneous.

WOOD CARVING EXHIBITION.

The fourth Exhibition of Works in Wood an Wood Carving, arranged under the auspices of th Carpenters' and Joiners' Company, was opened a Carpenters-hall, London-wall, on Monday, 26t October, and will be continued until Saturday, th 14th of the present month. The exhibition consist of objects sent in in response to the offer of prize made by the above companies, and also of specimen of old wood carvings lent from the South Kensingto Museum and other collections. The prizes we offered under seven divisions, viz.:—Division 1.–

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* The Executive Committee consisted of Mr. Henry Cole, Mr. C. Wentworth Dilke (afterwards Sir C. Wentworth Dilke, Bart.; he died 1869), Mr. George Drew, Mr. Francis Fuller, Mr. Robert Stephenson (the distinguished egnineer; he died 1859), and Mr. M. Digby Wyatt (Secretary). The following were the Treasurers:—Mr. P. Le Neve Foster, Mr. Joseph Payne, and Mr. Thomas Winkworth.

† The Right Hon. W. E. Gladstone is now the sole survivor of the original Commission.

‡ The constitution of this committee was afterwards modified. Mr. Stephenson retired, and his place was taken by Lieut.-Colonel (afterwards Sir W.) Reid, who became chairman. Mr. Drew and Mr. Fuller took no part in the proceedings of the committee, though their names were kept on it.

* A few months later (August 15, 1850) the Commissio was granted a Charter of Incorporation, by which it wa created a corporate body, with executive powers. Under thi authority it still exists.

† The official history of the Exhibition is given in the firs three reports of H.M. Commission for the Exhibition of 1851 published in 1852 and 1856. A good account of it is also give in the introduction to the 1862 Exhibition Catalogue previ ously referred to.

odels in constructive carpentry, in six classes, consting of roofs, bridges, scaffolding, staging, &c. ivision 2.—Models in ornamental carpentry, in six asses, showing skill in construction and architecral effect in various buildings. Division 3.—Models specimens of joinery, in seven classes, consisting staircases, window-frames, pulpits, cornices, school rniture, bookcases, &c. Division 4.—Prizes to the ade for a chair for ordinary use, a hall bench with rving, and a table constructed by British workmen. ivision 5.—Carving, handwork, nine classes, consting of friezes, panels, &c. Division 6.—Carving, ndwork, prizes offered for moulding, panel, pateras, nt cover, &c. Division 7.—Drawings at Carnters'-hall, open to carpenters, joiners, and wood rvers. In the first division, there are eleven exbits in Class 1, one in Class 2, five in Class 3, three Class 4, ten in Class 5, and two in Class 6. In ivision 2, there are seven in Class 1 and seven in lass 2. In Division 3, there are six in Class 1, nine Class 2, three in Class 3, one in Class 4, one in lass 5, three in Class 6, and eighteen in Class 7. Division 4, three tables were sent, but no hall nch or chair. In Division 5, there are two carved pitals in oak in Class 2, six friezes in Class 3, two k pilasters and oak frieze for chimney-piece in lass 5, two panels in Class 6, four perforated panels Class 8, and several carvings of birds and flowers, nels, frames, chairs, caskets, frames, &c. In ivision 6, are specimens of mouldings and panels by ose under 18 years of age, and pateras and font vers by those under 16 years of age.

Many of these works show considerable techcal skill, and many are of good design, but is important that students should understand at there is something more in design than a ere reproduction of old work. No wood carver n be successful who has not studied carefully the ork of the masters in his art, but it is necessary realise why the good work is admired, and it ust not be supposed that all the old work is cessarily good. The perfect condition of much of e old carving should teach the student to eschew nder work in exposed positions, which is likely to broken off. Even in the most delicate old work it ll be found that the exposed parts are so made as protect the more delicate portions. Much of the bour spent upon the realistic treatment of birds and wers seems to be misdirected, and carvings that ust needs be kept under glass are not useful.

There are some fine specimens of old wood carvings the loan exhibition. Two very fine pieces are sent the South Kensington Museum, one a chimneyece of carved oak, from a hunting lodge of King mes I. at Bromley-le-Bow, which is dated 1606: e arms are very fine and bold, and would form a od model for the student in the treatment of heralc subjects. Mr. Harry Hems contributes a panel conining 112 examples of 15th century carvings from od screens in Devonshire churches, some of which e very beautiful, and worthy of much study. Mr. Thomas Wardle sends a fine carved oak chest and oak arm chair, and an oak box front, all of the 17th century. Professor Banister Fletcher exhibits an exquisitely carved Greek cross, and Mr. George Donaldson some remarkable carvings of the 16th and 18th centuries; of the former are two carved panels by Berruguete (a Spanish carver, born 1480), and of the latter a carved frame with medallions, by J. Coppe, 1720. Other fine specimens have been lent by Mr. Guy Francis Laking, Mr. George Alfred Rogers, Messrs. John G. Crace and Son, and others. Mr. W. C. Phipps exhibits some remarkable specimens of wood destroyed by insects, and also cases of the insects who do the damage.

Notes on Books.

PATENTS FOR INVENTIONS RELATING TO MACHINE-GUNS AND AUTOMATIC BREECH-MECHANISM. By W. R. Lake. London: Haseltine, Lake & Co.

The principal object of this work is to give an account of Mr. Hiram Maxim's inventions relating to automatic guns, but it includes also a very full history of the invention of the machine-gun. In an introductory note, Mr. Lake refers to many of the early inventions for constructing multiple guns or batteries of guns, and he mentions the patent granted to James Puckle in 1718 for a gun with one barrel and rotating chamber-pieces, but he does not refer to the much earlier inventions described in a patent granted by Charles I. in 1637 to William Drummond, of Hawthornden, one of which appears to have been a mitrailleuse formed of musket barrels, "conjugate" or fashioned together, while another "box pistol, or "muskett box" seems to have been a sort of repeating gun.

The body of the work includes a list of British patents granted during the last half century, that is from 1854 to 1895, relating to machine or battery guns. Following this come abstracts of the specifications of these patents with the exception of those relating to automatic guns, which are dealt with separately. Abstracts of Mr. Maxim's 26 specifications are given together, and supplementing this are abstracts of specifications of patents granted to other inventors for improvements relating to automatic guns. So far as Mr. Lake has been able to ascertian, no one anticipated Mr. Maxim in the application of the recoil to the working of the breech mechanism, and the consequent construction of an automatic gun, a gun which once started continues to fire as long as it is supplied with ammunition, though the recoil had previously been used to operate the return of the gun to the firing position, and for some other purposes. At the conclusion, a short account is given of the different machine-guns which have been adopted for practical use, the French mitrailleuse, the Gatling, Nordenfeldt, Gardner, Hotchkiss, and some other guns.

A PRACTICAL HANDBOOK OF RELIEF ETCHING ON METAL, OR CHEMIGRAPHY. Handbuch der Chemigraphie, Von W. F. Toifel, Zweite Vermehrte Auflage. Vienna, Pest and Leipzig, 1896, Hartleben's Publishing House. Price 3m. 25pf. (about 3s. 3d.)

It may not be out of place to introduce the notice of a new edition of Herr Toifel's Handbook of Chemigraphy, by giving an instance of relief or typographic etching in its simplest form; relief or typographic etching being the reverse of that intaglio etching which is so familiar to every artist. It is quite practicable to write or sketch on a plate of zinc with an ordinary steel pen dipped in melted wax, which for convenience may be coloured black; but as a hint to anyone trying the experiment, it may be mentioned that the pen should be kept warm by a minute gas jet playing on its crown, this jet being supplied by an indiarubber tube, which need not be larger than a thin string. If the plate be now etched with weak acid, say one volume of nitric acid to twenty of water, the lines of the sketch will be left standing in relief as the general surface of the zinc is dissolved away; but if the etching were continued too long at this stage the acid would undercut, or dissolve away the metal under the wax lines. To obviate this, the depth of the first etching should not be more than the width of the narrowest line. The plate having been rinsed and dried, a hot iron is held some little distance above the surface, so that the wax melts and runs down over the sides of the relief produced by the etching, thus protecting these sides during another etching. By repeating these operations, and occasionally putting a little more wax on the now broadened lines, any required depth may be given to those parts of the plate which are not required to print. Herr Toifel's work is essentially a handbook for the practitioner who wishes to keep current with the time, and in this second edition will be found full descriptions of the chromated gum and albumen methods, also the American fish glue, or enameline process, together with other modes of working which have been initiated or become important since the issue of the first edition.

Like many who treat a subject thoroughly and usefully, from the practical side, Herr Toifel rather fails on the historical side; for he tells us that chemigraphy was unknown in the first decade of the present century, whereas chemigraphic etching in relief on metal, arms, and ornaments was practised in the time of Coster and Guttenberg, and a chemigraphic printing block, etched on stone in the 16th century, is to be seen at Munich.

The thorough and practical way in which the author treats the autographic methods or transfer methods should make his work specially useful to those who hold themselves ready to supply blocks rapidly from the mixed instructions and copy which the block-maker so often receives. The details of etching such zinc plates as bear the resist image (the equivalent of our sketch in wax), whether obtained by autographic transfer or photographic means, are not only given in such full detail as to make the instructions amply sufficient for any intelligent beginner, but all the more important modifications in treatment are described.

Herr Toifel's book is a volume of Hartleben's "Library of Chemical Technology" (Chemisch-technisch Bibliothek), and it retains its old number (100) in the series, although during the ten years or so which have elapsed since the issue of the first edition the series has run on to No. 223, "Specialities in Paper," and 224 "Cyanogen Compounds." This series of technical works—most of them written rather from the practical than the theoretical side—deserves to be better known in this country; and if English manufacturers and workers realised their existence, and profited by them, we might, perhaps, hear less of the supremacy of the Germans in certain chemical manufactures. There is, however, the difficulty as to language; and it is perhaps hopeless to dream of the issue of such a series in English, or of the English manufacturers and workers acquiring such knowledge of the German language as would make the series fully available in the present form.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 9...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Inaugural Address by the President, Professor Armstrong.

Imperial Institute, South Kensington, S.W., 8½ p.m. Professor W. Dunstan, "Work of the Scentific and Technical Department of the Imperial Institute."

TUESDAY, Nov. 10...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. G. Cruttwell, "The Tower Bridge: Superstructure." 2. Mr. Sam. G. Homfray, "The Machinery of the Tower Bridge."

Photographic, 5A, Pall-mall-east, S.W., 8 p.m. 1. Mr. Chapman Jones, "A New Form of Apparatus for Measuring the Light Reflected from Prints." 2. Mr. Charles E. Benham, "A Theory of the Röntgen Phenomena."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Opening Address by the President, Sir Clements Markham. 2. Mr. Arthur Montefiore Brice, "The Jackson-Harmsworth Expedition and the Story of Last Year's Work."

Anthropological, 3, Hanover-square, W., 8½ p.m. Papers and exhibitions by Mr. P. L. Sclater, Mr. H. Balfour, and Mr. C. H. Read.

Zoological, 3, Hanover-square, W., 8½ p.m. Papers by Mr. Oldfield Thomas, Mr. W. E. de Winton, Mr. Alfred E. Pease, and Mr. R. Lydekker.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. John Lowles, "Inter-British Trade."

THURSDAY, Nov. 12...Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. John Gavey, "Telephone Trunk Lines."

FRIDAY, Nov. 13 ... Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Professor Threlfall and Mr. Pollock, "Röntgen Rays." 2. Dr. Barton and Mr. Bryan, "The Absorption of Electric Waves along Wires by a Terminal Bridge."

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FRIDAY, NOVEMBER 13, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-third Session will be held on Wednesday evening, the 18th of November, when the Opening Address will be delivered by Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Chairman of the Council. The subject of the Address will be "India: its Arts, Manufactures, and Commerce."

Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 18.—Opening Address by Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Chairman of the Council.

November 25.—"Recent Developments in Mechanical Road Carriages." By W. Worby Beaumont, M.Inst.C.E. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

December 2.—"The Teaching of Economics." By W. A. S. Hewins, M.A. Sir Owen Roberts, M.A., will preside.

December 9.—"Mining at Great Depths." By Bennett H. Brough, Assoc.R.S.M.

December 16.—"The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the original Instruments for which it was written.) By Arnold Dolmetsch.

Papers for meetings after Christmas:—

"Children's Sight." By R. Brudenell Carter, F.R.C.S.

"Light Railways." By Everard R. Calthrop.

"Cycling—Historical and Practical." By George Lacy Hillier.

"A Half Century of Line Engraving, 1780-1830." By George Clulow.

"Lithography as a Mode of Artistic Expression." By Leo McCulloch.

"The Artistic Treatment of Heraldry." By W. H. St. John Hope, M.A.

"Dairy Produce and Milk Supply." By M. J. Dunstan, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. Esson, M.Inst.C.E.

"London Water Supply." By Percy F. Frankland, Ph.D., F.R.S.

"The Chemistry of Tea." By David Crole.

"The Evolution of the Silver Question." By Moreton Frewen.

Indian Section.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock:—

January 21, February 11, March 11, April 1, 29, May 20.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock:—

January 19, February 16, March 16, April 6, May 4, 25.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 26, February 9, March 2, 30, April 27, May 11.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

Prof. Vivian B. Lewes, "The Use of Gas for Domestic Lighting." Three Lectures.

November 23.—Lecture I.—The principles of illumination and the measurement of light—Illuminating value and illuminating effect — Domestic lighting — Flat flame, Argand, and regenerative burners.

November 30. — Lecture II. — Incandescent mantles and burners—The effect of globes in diffusing and absorbing light—Street lighting—Atmospheric influences and the penetration of light.

December 7.—Lecture III.—Gaseous illumination where coal-gas is not available—Oil-gas and its properties—Acetylene: its manufacture and use—Acetylene burners and generators—Railway and tramcar lighting.

William Burton, F.C.S., "Material and Design in Pottery." Four Lectures.

January 18, 25, February 1, 8.

C. F. Cross, F.C.S., "The Industrial Uses of Cellulose." Three Lectures.

February 15, 22, March 1.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Four Lectures.

March 15, 22, 29, April 5.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Thursday Evenings, at Eight o'clock:—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.
January 28, February 4, 11, 18, 25, March 4.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 6th and 13th of January, at Seven p.m., by CLINTON T. DENT, F.R.C.S., Past-President of the Alpine Club, on "The Growth and Demolition of Mountains."

INDIAN SECTION COMMITTEE.

A Meeting of the Committee of the Indian Section was held on Tuesday, 10th inst., at 4 p.m. Present:—Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., in the chair, Jervoise A. Baines, C.S.I., Sir George Birdwood, K.C.I.E., C.S.I., Sir Charles H. T. Crosthwaite, K.C.S.I., E. C. Danvers, Sir Juland Danvers, K.C.S.I., W. Lee-Warner, C.S.I., Sir James B. Lyall, G.C.I.E., K.C.S.I., Alexander Rogers, Thomas H. Thornton, C.S.I., D.C.L., W. Martin Wood, with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, Secretary of the Section. The arrangements for the Session were considered.

Miscellaneous.

BALATA INDUSTRY OF DUTCH GUIANA.

Her Majesty's Consul at Paramaribo, in a report upon the balata industry of Dutch Guiana, says that the collection of the milk of the bullet tree there is an industry of quite recent creation, and as such was originated by British capital. The bush negroes were in the habit of drinking the milk of the bullet tree, and mixing it with their chocolate. They are well aware of the injurious effect of taking spirits immediately after having drunk bullet tree milk. According to the Government Botanist and Superintendent of the Botanical Gardens, British Guiana, the bullet or bully tree, *Mimusops Balota*, from the bark of which balata is obtained, is a large forest tree, belonging to the order *Sapotaceæ*. It reaches maturity at a height of 120 feet, with usually a large spreading head, and a trunk 60 to 70 feet long and 4 to 5 feet in diameter. According to another authority, who has had very extensive personal experience of balata collecting in Netherlands Guiana, the tree is found in the Netherlands Corsutyne Border in great abundance in the low-lying zone of fluvio-marine deposit. It is also found in the higher lands of the interior, but in a less abundant and more scattered condition. On the bullet tree bearing grounds in forests where they are plentiful, the observer may see from 20 to 30 trees, of a thickness of 12 to 30 inches, within a radius of 100 feet around him; where the tree is less plentiful, the observer will only see two or three trees within the same area. The bleeder usually looks over his head, and discovers the tree by its foliage. He also knows that the bullet tree must be near when he comes upon certain kinds of bush. Above a trunk, the thickness of about 30 inches, the tree is usually not worth bleeding. In comparison with the rubber tree on the Amazon, the distribution of the bullet tree in Dutch Guiana is much more limited. Dr. Hugo Müller, speaking of the commercial character of balata, says:—"It commands a higher price than guttapercha, and that in itself is a proof of its usefulness. It is used almost in all cases in which guttapercha is used, but on account of its higher price, only for superior purposes. It seems that balata is treated by the manufacturers simply as a superior kind of guttapercha, and therefore its name disappears when manufactured, nevertheless balata is distinctly different from guttapercha, and this is especially manifested in some of its physical characters; for instance, it is somewhat softer at ordinary temperature and not so rigid in the cold. The chemical composition, however, is probably quite identical with that of guttapercha and caoutchouc. In one respect balata shows a very marked and important difference from guttapercha, and that is in its behaviour under the influence of the atmosphere, whilst guttapercha, when exposed to light and air, soon becomes altered on the surface and changed into a brittle resinous substance, into which the whole of the mass is gradually converted, balata, on the other hand, is but slowly acted upon under these circumstances." The balata industry in Dutch Guiana is in its infancy. In Surinam the forests which have been bled are abandoned, and new lands are sought for and exploited. Only those areas where an abundance of trees is to be found have been selected. On areas where 100 trees are found, it sometimes happens that about 75 per cent. only will give milk at the particular period when the bleeder visits them, and that at some later period the remaining trees will also run, but as the bleeders have gone beyond that particular section, it is not profitable to come back and bleed the remaining trees just at the special time when they are ripe for it. There seems to be little doubt that there is yet considerable room for the further development of the balata industry in Surinam. The future of the industry is, however, fraught with greater risks, as more remote districts have to be explored and opened up. These lands are situated higher up the rivers, and the expenses of reaching and keeping up communication with them is considerably increased by reason of the presence of falls and obstructions to the navigation of the main fluvial arteries of this colony in their higher reaches. On the Maroni river, a few Para rubber trees have been met with, but to a very limited extent. It is hardly possible that the balata bleeders, who are well acquainted with the *Forsteronia gracilis* and *Hevea*, should not collect this milk if they found the trees in such numbers as to make it worth their while tapping them. Enquiries for various collections tend to show that though various other milk-giving trees are met with, their number is too limited to make it profitable to breed them. The forests are all the property of the Crown, and are leased by the Colonial Government at a rental of 10c. (1d.) per hectare (2·47 acres) per annum, for the exploitation of balata only, and that in conformity with the Balata ordinance of the colony. The bleeder receives advances from his employers against which he contracts to deliver balata. For his balata he receives about elevenpence per pound. A very successful bleeder will get as much as ten gallons a day. A gallon of milk will dry to about four pounds of balata. The bleeders are mostly recruited from Berbici, in British Guiana, and about 1,000 men are at present employed in Dutch Guiana in the industry. The very hot and very wet seasons are not good for balata breeding. The trees blossom in August and the seed drops about the month of November, when the new leaf shoots out. By the end of January the milk obtains the condition when it runs most plentifully. The leaves of the old trees, the milk of which is not easily obtainable, are dark brown on the lower side and green above; the younger trees are light green on both sides. During the flowering season the milk does not flow to any paying extent. The leaves of the young trees are thick, and when broken the milk issues freely from the wounds. After the month of August to the middle of January no work is done, this leaves about eight working months. As regards the progress of the balata industry it appears from statistical returns that the quantity of balata exported amounted to 108,286 kilogrammes (kilogramme = 2·204 lbs. avoirdupois) in 1894, and 133,681 kilogrammes in 1895. The values were respectively £216,573 and £267,362. During the year 1895, 335,484 hectares of land were granted by the Government for the exploration of the balata industry.

SALT PRODUCTION IN RUSSIA.

When rich deposits of salt were discovered and reported at Bardymkul, in the region of Ferghana, Turkestan, in the autumn of 1895, Belgian capitalists sent out engineers to investigate the strength of the beds and to report thereon. The engineers estimated that an area of two square versts (verst = ·663 of a mile) contained a milliard lbs. (36,112,000,000 lbs.) of salt. These salt deposits are situated on the lake of Bardymkul, in the neighbourhood of Chodjent, in Ferghana, Turkestan. The salt, says Consul-General Karel, is gained by dynamite explosion, then put into bags and sent by camels to Samarcand, 239 miles, and thence, by the Transcaspian Railway, distributed to the different towns on this line, and also over Usun-Ada, as far as Astrakhan and to Kura, mainly for salting caviar. The salt is of excellent quality, as according to analysis, it is superior to the best quality of English salt. For 1896, the production is estimated at 216,672,000 lbs., of which 144,480,000 lbs. are estimated for local consumption in Central Asia; 54,168,000 lbs. for the Baltic ports; and 18,056,000 lbs. for the salting of caviar and sausage casings. It is the intention of the company to supply India with salt, and it is said that there are excellent opportunities for a large sale there, because the salt can be transported at cheap rates through Samarcand, Usun-Ada, Baku, Batoum, &c.

THE LIGHTING INDUSTRY IN GERMANY.

The consumption of gas in the German Empire in 1895, aggregated, according to the latest official statistics, 733,000,000 cubic metres, for the production of which 2,750,000 tons of coal were required. The number of gas jets was 5,734,762. The number of gas motors was 15,644, representing 52,000 horsepower. The Frankfort Gas Company reports an annual production of 5,600,000 cubic metres, as against 4,000,000 in 1885. The Berlin Municipal Gas Works produced 103,913,000 cubic metres, as against 74,337,000 in 1885. The English Gas Company at Berlin produced, in 1895, 32,282,000 cubic metres, as against 30,900,000 cubic metres in 1883. These figures are of special interest, in view of the fact that the Berlin electric plants were erected about 1885. The *Electrotechnische Zeitschrift* recently published a mass of statistics relating to 36 works for the supply of electricity in Germany, half of them being municipal, of all kinds and sizes. It is recorded that in 1895 there was a satisfactory increase in the demand for current as compared with the previous year, at the same time there was a similar increase in the consumption of gas. According to one writer, the future of the gas industry in Germany now stands on a firmer basis than that of electricity. Incandescent gas burners, gas stoves, and gas engines are stated to have left their rivals far behind. In spite, however, of all technical improvements in the lighting industry and the enormous progress of gas and electric lighting during the last ten years, the consumption of petroleum in Germany has not only kept up, but it has increased steadily for the last 30 years. From 1866 to 1870 the average annual import amounted to 70,436 tons (a ton is equal to about seven barrels); from 1871 to 1875, to more than twice as much, namely, 154,504 tons; from 1876 to 1880, 235,280 tons; from 1881 to 1885, 389,335 tons; and from 1886 to 1890, 556,887 tons. From 1890 the importation has been as follows:—1891, 675,528 tons; 1892, 743,433 tons; 1893, 765,100 tons; 1894, 785,102 tons; and 1895, 811,058 tons. The consumption per head of population from 1866 to 1870 was 1·87 kilogramme, while 20 years later—that is, from 1886 to 1890—it was 11·61; and from 1891 to 1895 as much as 14·82 kilogrammes. The home production is comparatively insignificant, but nevertheless it is showing a steady growth. In 1880 the German oil wells produced 1,309 tons; from 1881 to 1885, an average of 5,665 tons annually; from 1886 to 1890, 11,513 tons; and from 1891 to 1896, 15,620 tons per year. The German oil market is supplied almost exclusively by the United States, and a small quantity is furnished by Russia. In 1895, 749,258 tons were received from the United States, and 55,078 tons from Russia. The total value of the German petroleum import was subject to considerable fluctuations. During the last ten years the maximum value was reached, in 1888, with 84,600,000 marks, while the minimum value was in 1894, namely, 45,300,000 marks for 785,102 tons.

Correspondence.

SCHOOL OF CARVING, BRIENZ, SWITZERLAND.

You were good enough last spring, in answer to an inquiry, to send me a pamphlet, being the annual report connected with the carving school at Brienz, situated some nine miles from Interlaken. The information seemed what I required, so I immediately addressed a letter to Herr Kichnholz, Directeur de l'Ecole de Sculpture, Brienz, Canton Berne, on the subject of lessons in the art, and some details. To this communication, and another sent later, no reply was received. I much regretted this apparent neglect on the part of the school authorities, as I was prepared, along with a sister, to spend three months there, and to pay liberal fees during the past season.

Under the circumstances, I applied to the British Consul, M. G. de Muralt, in Berne for a teacher, and through his kindly attention and promptitude was fortunate in arranging with a very clever Austrian sculptor there, in whose studio myself and sister studied very profitably during the three months we expected to spend at Brienz. Later in the season, being still desirous to see the Brienz School of Carving, we, about the middle of August, paid it a visit, and although the school was not in full operation, the vacation having scarcely expired, we obtaine some information and examined the methods an work of the few students on the spot. It appeare that the register was full, and that there were n foreigners among the students; facts which, in th eyes of the authorities, probably afforded sufficien excuse for not replying to my letters. The fees wer said to be very small, nominal indeed, but a deposi of fifty francs is lodged by each accepted student as sort of guarantee that he will attend the entire cours of lessons, which extend over three years, when th deposit is returned. As to the usual method of th carvers, it, in the case of single animals, such a horses or bears, is simplicity itself. The outline is traced upon the block, then with a fine fret saw the extraneous wood is sharply cut away, after which the carving commences. No special measurements seemed to be taken, the usual slow and monotonous process called "pointing" appears to be almost wholly abandoned, everything, after obtaining the initial outline, being done by the eye. Considering the admirable results, the previous training of the students both in freehand drawing and modelling must be both strict and sustained.

The eagle, in every kind of attitude, being one of the favourite subjects, stuffed specimens are numerous, and in order to keep pace with the demand, four or five of the finest birds to be found are annually shot and artistically prepared for the use of the students. Another subject for artistic treatment in constant request is the bear. These animals are kept, at the expense of the Government, in pits in several parts of Switzerland, particularly at Berne, where the peasant carvers flock in great numbers at holiday periods to study their uncouth gambols. The tools in use are much the same as those employed at home, being mostly of Sheffield manufacture, while the benches are small and handy, each with an end screw and row of square slots.

Besides the Government School of Carving, there are many private studios where beautiful work is executed. Indeed, Brienz is a village of wood sculptors, some of them doubtless in a humble way of business, but all producing objects of merit. As the owners of these workshops could scarcely find a market for their carvings unaided, they are helped by one of their townsmen, M. Jager, to whose kindness I was indebted for introduction and pilotage through the school of carving and several private studios. This gentleman travels over Europe, and occasionally visits London with samples, returning to Brienz with orders in time to set the villagers going for the winter. He supplies them with funds and wood, collects their finished work each week end, and, while a benefactor to his poorer neighbours, is doubtless reaping a fair return himself.

In the face of all this artistic industry and success, the surprising thing is that the Swiss authorities—knowing, as they must, of the popularity of amateur wood carving in Great Britain—have not yet offered any encouragement to foreigners to attend their school at Brienz. WILLIAM COCHRAN.

Overdale, Dunblane, Perthshire,
4th November, 1896.

EXHIBITION OF 1851.

As one of the oldest members of our Society, and perhaps the *doyen* of those connected with the first International Exhibition the world ever saw, I would note that the Right Hon. W. E. Gladstone is hardly now the sole survivor of the original Commission of 1851, Lord Playfair having been one of the two Special Commissioners for communication with localities so essential to success.

There are now few remaining amongst the superintendents or the jurors. As an exhibitor and a recipient of a Society of Arts medal in 1848, I can well recall the interest taken in the display made at the Society's house and the issue thereof in 1851—having had charge of the Fine Arts Court, and the books, &c., under Owen Jones, as also in 1862, on both occasions receiving "prize" and "service" medals.

Of the two valuable records in the form of Jury Reports, 1851 appeared under the auspices of the Royal Commission, that of 1862 being issued by the Society of Arts.

As a "guarantor" I can well recall the great opposition and disaster predicted in 1851, and the sad events that heralded 1862—the death of the Prince Consort, civil war in America, and a cotton famine in Lancashire. The Press and country were with the last great show of 1862, but for all I well remember Earl Granville saying to Sir Wentworth Dilke, "Oh, for the opposition of 1851! that was a stimulant to effort wanting now."

Prior to 1851 the words "The Exhibition" applied to the Royal Academy of Arts alone, since then that designation has been lost. Our two great Exhibitions enter into the domain of history, being the most remarkable event in the longest reign.

It is a remarkable fact that in the year 1851 when the international show left a large surplus all other exhibitions prospered in a like degree showing how wide was its attractive influence.

JOHN LEIGHTON, F.S.A.

[Lord Playfair (then the Right Hon. Lyon Playfair, C.B.) was elected a member of the Commission in July, 1869. There is no survivor other than the Rt. Hon. W. E. Gladstone of the original Commission.]

General Notes.

ROYAL INSTITUTION. — Dr. Alexander Scott, M.A., D.Sc., has been appointed to be superintendent of the Davy Faraday Research Laboratory of the Royal Institution, the directors already appointed by the managers being Lord Rayleigh and Prof. Dewar. After the meeting on the 2nd inst., the members inspected the new rooms which have been lately added to the library of the Royal Institution through the munificence of Dr. Ludwig Mond, F.R.S., which rooms will provide increased accommodation for the members on the occasion of the Friday evening meetings.

GLASS SUBSTITUTES.—In reference to the article on "Glass Substitutes in Germany," (see *ante* p. 858), in which a description of a material called "tectorium" is given from a report of the United States Consul at Frankfort (where it is described to be an English invention), the New Wire Wove Roofing Company, Limited, wish to state that the English invention referred to is their material "Duroline."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 16...Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. W. Crookes, "The Diamond Mines of Kimberley."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Dr. Lindsey Johnson, "The Eye considered as an Electrical Organ."

TUESDAY, Nov. 17...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Papers by Mr. G. Cruttwell, on "The Tower Bridge: Superstructure," and by Mr. Sam. G. Homfray, on "The Machinery of the Tower Bridge."

Statistical, in the Theatre of the United Service Institution, Whitehall, 5½ p.m. Inaugural Address by the President, Mr. John Biddulph Martin, "Some Developments of Statistical Research and Methods during Recent Years."

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Eddington, "Successful Half-tone Illustration."

WEDNESDAY, Nov. 18 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Address of the 143rd Session by Major-General Sir Owen Tudor Burne, "The Arts, Manufactures, and Commerce of India."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. William Ellis, "Report on the International Meteorological Conference at Paris, September, 1896." 2. Hon, F. A. Rollo Russeil, "Haze, Fog, and Visibility."

Microscopical, 20, Hanover-square, W., 8 p.m.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. Mr. E. P. Rathbone, "Some Economic Features in Connection with Mining on the Wittwatersrand Goldfields."

THURSDAY, Nov. 19...Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. G. Ridewood, "The Structure and Development of the Hyo-branchial Skeleton and Larynx in Xenopus and Pipa, with some remarks on the affinities of the Aglossa." 2. Rev. Thos. R. R. Stebbing, "Amphipoda, from the Copenhagen Museum and other sources."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. P. H. Ray, (i) "Mercury Hypontrites;" (ii) "The Nitrites of Mercury and the conditions under which they are formed;" (iii) "The Interaction of Mercurous Nitrite and the Alkyl Iodides." 2. Mr. T. H. Holland, "Crystallography of the Monohydrated Mercurous Nitrite." 3. Dr. H. Lapworth and Prof. F. Stanley Kipping, "Sulphocamphoric Acid and other derivatives of Camphorsulphonic Acid."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. E. R. Ashton, "In Eastern Lands."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of t following Transactions of Societies and Periodicals.

TRANSACTIONS, &c.

American Chemical Society, Journal.

American Institute of Electrical Engineers, Transactions.

American Philosophical Society, Proceedings and Transactions.

American Society of Civil Engineers, Transactions and Proceedings.

Association of Engineering Societies, Journal.

Australasian Association for the Advancement of Science, Report.

Bath and West and Southern Counties Society, Journal.

British Association for the Advancement of Science, Report.

British Guiana, Royal Agricultural and Commercial Society, Journal.

British Horological Institute, Horological Journal.

Camera Club, Journal.

Canada, Royal Society, Proceedings and Transactions.

Canadian Institute, Transactions.

Canadian Society of Civil Engineers, Transactions.

Chemical Society, Journal.

Cleveland Institution of Engineers, Proceedings.

Cymmrodorion, Honourable Society of, Transactions

East India Association, Journal.

Farmers' Club, Journal.

Franklin Institute, Journal.

Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.

Geological Society, Quarterly Journal.

Imperial Institute, Journal.

Incorporated Gas Institute, Transactions.

India, Geological Survey of, Memoirs, Records and Palæontologia Indica.

——, Government of, Agricultural Ledger.

Indian Meteorological Department, Report.

Institute of Bankers, Journal.

Institution of Civil Engineers, Minutes of Proceedings.

Institution of Electrical Engineers, Journal.

Institution of Engineers and Shipbuilders in Scotland, Transactions.

Institution of Junior Engineers, Record of Transactions.

Institution of Mechanical Engineers, Proceedings.

Institution of Mining and Metallurgy, Transactions.

Institution of Naval Architects, Transactions.

Iron and Steel Institute, Journal.

Jamaica, Institute of, Journal.

Japan, College of Science, Imperial Universit Journal.

Japan Society, Transactions and Proceedings.

Kew Gardens Bulletin.

Linnæan Society, Journal.

London Association of Foremen Engineers ar Draughtsmen, Publications.

London Chamber of Commerce, Journal.

Lyon, Société d'Agriculture, Sciences et Industri Annales.

Manchester Literary and Philosophical Societ Memoirs and Proceedings.

Massachusetts Institute of Technology. Technolog Quarterly and Proceedings of the Society of Art

Munich, Polytechnischer - Verein, Bayerisches I dustrie-und-Gewerbeblatt.

National Association for the Promotion of Technic and Secondary Education. Record.

National Indian Association, "The Indian Magazi and Review."

Nederlandsche Maatschappij ter Bevordering va Nijverheid, Wekelijkoche Courant de Nijverheid.

New South Wales, Royal Society, Journal and Pr ceedings.

North-East Coast Institution of Engineers and Shi builders, Transactions.

Paris, Conservatoire National des Arts et Metier Annales.

——, Société d'Encouragement pour l'Industri Nationale, Bulletin.

——, Société de Geographie Commerciale, Bulletin.

——, Société Internationale des Electriciens, Bulleti

——, Société Nationale d'Acclimatation de Franc Revue.

Patent Agents, Chartered Institute of, Transactions.

Patent-office, Illustrated Official Journal.

Pennsylvania (Western), Engineers' Society of, Proceedings.

Pharmaceutical Society, "The Pharmaceutica Journal."

Philadelphia, Academy of Natural Sciences, Proceedings.

————, Engineers' Club Proceedings.

Quekett Microscopical Club, Journal.

Royal Agricultural Society, Journal.

Royal Colonial Institute, Proceedings.

Royal Cornwall Polytechnic Society, Annual Report.

Royal Geographical Society, "The Geographical Journal."
Royal Institute of British Architects, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Photographic Society of Great Britain, "The Photographic Journal."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Journal.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Colliery Guardian.
Colonies and India.
Commerce.
Cosmos; Revue des Sciences.
Eclairage Electrique.
Education: Secondary and Technical.
Electrical Engineer.
Electrical Review.
Electrician.
Electricien.
Electricity.
Engineer.
Engineering.
Engineering Record (New York).
English Mechanic.
Gardeners' Chronicle.
Gardening World.
Herapath's Railway Journal.
Indian and Eastern Engineer.
Industries and Iron.
Invention.
Iron and Coal Trades Review.
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
Medical Press and Circular.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Photographic News.
Photography.
Practical Engineer.
Produce Markets' Review.
Publishers' Circular.
Queen.
Revue Industrielle.
Sanitary Record.
School Board Chronicle.
Schoolmaster.
Scientific American.
Statist.
Surveyor.
Transport.
Textile Mercury.
Warehousemen and Draper.

Fortnightly.

Brewers' Guardian.
Corps Gras Industriels.
County Brewers' Gazette.
Finance Chronicle.
Irish Builder.
Jeweller and Metalworker.
Moniteur des Produits Chimiques.
Perak Government Gazette.

Monthly.

Arms and Explosives.
Bookseller.
Brewers' Journal.
Building Societies' Gazette.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette.
Dyer and Calico Printer.
Educational Times.
Electrical Plant and Electrical Industries.
Engineering Magazine (New York).
Furniture and Decoration.
Giornale del Genio Civile.
Hardware Trade Journal.

Inland Architect (Chicago).
Leather Trades' Circular.
Machinery Market.
Marine Engineer.
Mariner.
Moniteur Scientifique.
Musical Times.
Nautical Magazine.
Oestereichische Monatsschrift für den Orient.
Oils, Colours, and Dry Salteries.
Painting and Decorating.
Paper Makers' Monthly Trade Journal.
Plumber and Decorator.
Propriété Industrielle.
Railway Engineer.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sugar Cane.
Symons's Monthly Meteorological Magazine.
Textile Manufacturer.
Textile Recorder.
Ulster Agriculturist.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Bombay Gazette (Overland Summary).
Ceylon Observer (Overland Edition).
Daily Inter Ocean (Chicago).
Empire and South African Empire.
Home and Colonial Mail.
Home News.
London Commercial Record.
London and China Telegraph.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Shipping Gazette and Lloyd's List (Weekly Summary).
Siècle (Paris).
Times of Ceylon (Weekly Summary).
Times-Herald, Chicago.
Times of India (Overland Weekly Edition).
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